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School Science

A Journal of Science Teaching in Secondary Schools.

EDITED BY C. E. LINEBARGER.

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School Science

VOL. 1] MAY, 1901. [No. 3

OUT-DOOR SCIENCE IN SECONDARY SCHOOLS.

BY FREDERICK A. VOGT.

Principal of the Central High School, Buffalo, N. Y.

The first step to take in teaching science to young people and in popularizing the study among older people is to throw away much of the traditional polysyllabic phraseology and use a little common sense and good old Anglo-Saxon now and then—to teach nature, instead of science.

There is not only great danger in being too technical, but in telling too much. We all like to talk on our pet subjects. We rattle along, airing our opinions and pouring out big volumes of knowledge, and expect the poor pupils, like great dry sponges, to absorb the gracious gift. But they don't absorb it; it isn't their business; they belong to quite another sub-kingdom; and while we are just about to congratulate ourselves on our facility of expression and wise beneficence, we are rudely made aware that our eloquence was all lost; and, worse still, we have been guilty of repression, of stifling natural curiosity, and crushing what might become a priceless, inquiring, intellectual habit.

Is it any wonder that so few ever go on with their geology, mineralogy, botany, or zoölogy, after they leave school? What is our object as teachers? Is it to cram geology and botany down passive throats in one or two school terms, or is it to lead our students so gently and awaken so keen a desire that they shall study these sciences all their lives, to be a never-ending joy, a pure pleasure and a solace amid coming cares and darkening days?

So much for the language of the teacher, and now for the

means of giving reality to his teaching efforts. This can only be done by the laboratory method or investigation in the field. With the latter, out-door work, only, does this paper especially treat.

ACTUAL CONTACT WITH NATURE.

While I do not for a moment decry the use of books, either for collateral reading or for text-books—in fact, I plead for a wider reading and profounder study of the best scientific writers—still, I feel just as you must feel, that there is something radically wrong in much of our science teaching, and that we have come to regard books as more real than the earth, the sky, the rocks, the plants, and the animals, which are all about us.

Just why this is so, I am unable to understand. Nature is so lavish! On all sides, easy of access, are the phenomena and the realities, while the school-room is artificial, and the teacher, alas, in perfect keeping with the school-room.

Can it be that pupils are averse to actual contact with nature? Not at all. From the earliest childhood throughout life there is, in most persons, a remarkable turn toward curious investigation and thorough understanding of the things of nature. That I know from my own experience while teaching in the grammar schools.

One day I asked the pupils to bring me in any specimens of stones they might find in the vacant lots and the fields; and then I promised to give them a talk about these stones. I expected perhaps twenty or thirty specimens. What was my amazement and secret horror when, the next day and the next, came dozens and dozens of specimens, until in a few days I had over a ton and a half, containing 3,000 specimens. There were granites, gneisses, and schists, and quartzes; there were sandstones, slates, shales, limestones, glacial scratchings, marbles, and onyx; there were geodes, crystals, ores, stone hammers, arrow-heads, brick-bats, furnace slag, and fossils. I took everything smilingly, and at night the janitor and I buried many duplicates and the useless stuff in a deep hole where they wouldn't be likely to get hold of it again.

We soon possessed an excellent cabinetful, and had fine times talking about the making of stones—the crust of the earth—

former inhabitants, the great ice age, and such simple geology as they could understand; and they did understand; that did not end it. We studied plants in the same way; physics and chemistry, with home-made apparatus. Of course, it all took time, and a good deal of it, and there wasn't any extra pay for it, either; but there are labors whose recompense is far more precious than dollars and cents.

And so I find enthusiasm also for out-door science, among secondary pupils and among the great body of intelligent people of our cities; and if nature is so accessible, and pupils are so eager for its secrets, and we still worship books and ignore the visible objects and forces so freely at our disposal, there is no other conclusion to arrive at, except that the teacher himself is either too ignorant or too indolent to make proper use of them. It takes time; it needs enthusiasm; it needs a genuine love for the subject in hand, and a profound interest in and sympathy with the student.

The subjects in which field work may be made very useful are geography, geology, botany and zoölogy, and the objects are of course apparent to all. First, it cultivates a familiarity with nature, which is wholesome and desirable. We are living in an artificial age. Children nowadays get too much pocket money; there is too much theater; too much smartness; too much flabbiness for the real business of life; too much *blase* yawning; too many parties; too much attention to dress, the color of the necktie, the crease of the trousers, or the make of a gown. The only meaning science has for many of the richer classes is the curved ball of the pitcher, the manœuvers of the quarterback, or the manly art of self-defense.

I know of nothing that will counteract the indifference of parents and lead the young mind back to a simpler and more humanizing condition of life than to make it familiar with old mother earth, the stream, the valley, the tree, the flower, and the bird.

CORRECT OBSERVATION.

Another object of field work is to train habits of correct observation. Pupils ordinarily take too much for granted. They will swallow anything that is printed in a book, or that the

teacher may choose to tell, always providing the pupil is sufficiently awake to perform the function. It is hardly an exaggeration that they would believe the moon was made of green cheese, providing the statement came with august solemnity from the teacher's chair. There is too hasty generalization and a prevailing unwillingness to careful examination. Careful field work opens the eye and corrects much of this slovenly mode of thinking; creates honest doubt and questions an unsupported statement. The pupil wants to see the pollen on the bee before he believes in cross-fertilization; he wants to see rocks actually in layers before he will believe they could have been deposited in water, and he pounds up a fragment of sandstone to get at the original sand; he wants to see the actual castings before he will believe all that Darwin says about his wonderful earthworms; and few things escape the eye of the pupils who go out with the understanding that it is business and their duty to observe and take notes.

THE THINGS THEMSELVES.

Another object of field study is to see life in its environment. Stuffed birds and animals in cases are all very good; shells look pretty behind nice glass doors, and herbaria play a very important part; yet, after all, how much better to see a thrush's flight; to hear the pewee's song; how much more satisfactory to watch a snail creep and feed; how much more delightful to study the blossoming hepatica; to note its various leaves, its soil, its surroundings, and discover why it blooms at the very opening of springtime.

More can be learned from a handful of pebbles on the beach than a whole book written upon the same subject.

Yet another object is to acquire specific information not contained in books. The feel of a leaf, the odor of the honeysuckle or the pine, the cry of the kingfisher, the locomotion of a horse, and the locomotion of a cow, the formation of miniature gorges in a rainstorm, and the wearing of a shore under the action of the waves, these and countless other manifestations can never be described in mere words. The eye must see before the mind understands and believes.

PUPILS' COLLECTIONS.

Then still another advantage is the opportunity of collecting specimens for the school and private collections. Pupils think infinitely more of specimens they themselves gathered than of great museums which some one else has filled. They will study their own and treasure them.

And it is far better to know all about a small collection than to have a vague, hazy, mysterious notion of a great one. It is far better for the pupil to know that he is actually capable of understanding a tiny bit of nature than to be haunted by the feeling that somehow all this world of things and life is not meant for his understanding.

INTEREST THE PRINCIPAL CONSIDERATION.

I believe it is wiser to give the student a taste of geology and a taste of botany and zoölogy than to limit him to the exhaustive study of just one science. Once acquiring a healthy appetite and means of satisfying that appetite, and he will go on with these keys and unlock the treasure-houses of nature for himself. We sometimes forget that we are training pupils for life's duties and life's happiness.

When I take a class in geology on a hunt for fossils, and we come across a bed, I don't insist on everlastingly calling the trilobite we may find *Phacops latifrons* or *Isotoles gigas.* We call them all trilobites. We find they were crustaceous; how they lived, in what kind of waters; and we have gotten something out of our study; but if we rolled as a sweet morsel under our tongue the *Phacops latifrons* and *Isotoles gigas,* the pupils would forget them in ten minutes, and I wouldn't blame them.

Time enough later on for elaboration; one thing at a time. It is better to know a trilobite and a brachiopod than to know two polysyllabic species of either.

NEEDLESS PRETENSIONS.

A first-class way of killing a growing desire for scientific knowledge is to feed it on good strong doses of technical terminology; the process is quick and sure. The whole trouble lies in the fact that the teacher has forgotten that he himself was once young and came by his ponderous knowledge by slow degrees. I cannot see why some teachers imagine that they have a sort

of ten-story intellect when they haven't, and when something not so wonderful would far better answer the purpose. They certainly do not impose upon the pupils, for any one with half an eye can always size up the pupil's estimate of stately pretension.

GOOD TIMES OUT-OF-DOORS.

Another object that occurs to me, the last, and by no means the least, is to have a good time in the fresh air once a week.

To put on old clothes, carry your luncheon, and, after attending faithfully to business, collecting enough specimens, just have a jolly good time, and do as you please—fish, swim, loaf, climb trees, play games, build camp-fires, and be little children again in joyous freedom. This is not only highly desirable, but absolutely necessary; because boys, and especially girls, who have not been in the habit of roughing it, get very tired stooping and working, perhaps in the hot sun, and it is very important that a nice cool spot shall be selected for luncheon, and after that let them roam according to their own sweet will.

THE BUFFALO PLAN.

We are in Buffalo; well situated for excursions, and for seventeen years there has been organized what is known as the "Buffalo Field Club," or the "Society of Natural Sciences." The club was organized by the late Charles Linden, who had charge of the department of botany and geology in the Buffalo high school. Its members are made up of present pupils of the high school and its graduates and any other person who has a leaning toward science and a love for out-door work.

In the spring and autumn there are regularly planned excursions for each Saturday, and during the winter we have semi-monthly meetings, at which a paper is read and discussed, and scientific notes and observations compared. We at times have given complete and thorough courses in geology and botany, at which the attendance was often so large as to fill every seat in a room holding over three hundred. In our geology courses we give to each student specimens in hand, three or four sometimes, like sandstone, limestone, granite, and other common but interesting rocks. The museums of the "Society of Natural Sciences" is also at our disposal.

In botany we get ready a goodly supply of peas, beans, and other common seeds in various stages of sprouting, and these, too, are passed around in the little wooden trays grocers use in doing up butter. Then we have buds, roots, sections of trees, dried specimens of plants, and even simple chemical experiments, such as oxygen and carbonic acid gas, limewater, etc., etc.

These appliances are reinforced by stereopticon slides. All this takes time? Well, I should say it does! and labor, too; but what are we living for?

We began this sort of popular lecture teaching about seven years ago. We didn't know how it would take. There used to be nothing but empty benches at some of the best meetings of the "Mother Society of Natural Sciences," and when some of the older members dropped around that first night to give us a bit of encouragement, in what seemed to them a hopeless task, they found the place packed to the doors. Some of them were, no doubt, scandalized by the simple Anglo-Saxon language which profaned those holy precincts, but that night, and every night thereafter, settled one thing; that was the fact that the people are interested in science, and that they will come if the matter can be divested of its ridiculous and befogging pretensions. And be it understood the subject in hand and the great truths of science suffered the abatement of not one jot or tittle of their nobility, their grand and their inspiring simplicity.

In the high school it is an understood thing that each pupil in the out-door sciences shall make at least six excursions. There are regularly planned field excursions, which I or my assistants take charge of. If, on account of expense or hindrance at home, the pupil cannot go with us, or stay all day, an excursion must be made somewhere by trolley—to the river, park, an open trench, or only into the back yard; but somewhere the pupil must go with notebook to observe, study, and to report. But the localities we visit are so rich, and withal usually so attractive, that, in my experience, less than one per cent failed to attend. We always secure very low rates on the railroads.

The pupils like to go and want to go. I have had graduates come again and again who affirmed that the best study they ever had was geology, and the finest times of their school year were

the Saturday excursions. You get to know your students better in the field, and as to its taking too much time, I say it pays not only the teacher ten-fold, but does a wonderful lot for the student.

I taught geology and went on excursions every Saturday, and yet had the management of a high school with over 2,000 pupils. My class-room work and the excursions were the only fun, besides my salary, that I ever got out of my work. It is time well afforded; you yourself will renew your youth, and you are inculcating a habit in your students that is healthful, pure, ennobling; you are giving them that which will make a trip to the mountains, to the seashore of infinitely more value than it ever can be to the hordes of unfortunates who kill time, lolling on hotel verandas, or who yawn on the beach. A simple walk along a country road or over a field will be a beautiful picture gallery or wonderful museum, the catalogue of which will be in the heart of your former student.

In planning our class excursions we try to arrange matters so that the botanists, geologists, and zoölogists can all go together. It is not always possible, however, to combine the classes. In any case, the schedule of excursions must be carefully planned in order to get the best results.

For geology, that is not necessary; but it is desirable to begin with examples in dynamical geology; then structure and fossils; but that is the simplest matter of all. Any locality embraces scores of interesting facts, and these the pupils are directed to observe and jot down for a future report.

Every pupil is required to make a collection of at least thirty different rocks and fossils during the term. Pupils get much more than that, but as we give only one term to geology, and that includes laboratory work on thirty-three other rocks and minerals, it is unwise to make the study a burden.

I never require a book lesson the school day following on an excursion, because I want the pupils to feel perfectly free from anxiety, to rest from any physical fatigue, and to study the collection they have made. The report is not due for several days, so we just spend the hour in talking about the excursion. It may sometimes be wise not to meet at all, since a whole day was given up already. One must always remember that every-

thing can be overdone, and that the pupil has other studies besides out-door science.

THE MANAGEMENT OF SCHOOL EXCURSIONS.

The conduct of the excursion must be understood to be in your own hands, and that you are master, and you must be obeyed without question; otherwise, parents may have a perfect right to refuse their sons and daughters to your care. Of course there will always be one or two silly persons. There will be that excruciatingly facetious chap who wears a girl's hat, and doesn't think you meant what you said when you forbade any one to cross the high railway trestle. But he finds out, and is combed down to the queen's taste in short order. On the whole, it is singular how orderly and earnest an excursion party can be.

An excursion would lose much of its value unless observations were noted, drawings made, and specimens collected and exhibited in the class-room. The pupil should handle the specimens himself, and be made to describe what he sees. Here, again, is the great danger that the teacher will tell too much. It is amazing to find how much one can draw out of pupils by simply keeping at it. Make them tell why this piece of sandstone is gray and that red; why the stream was so winding, and what formed the bar and the sand spit at its mouth.

Now, all this field work can be gotten out of secondary pupils, and as far as we are concerned in Buffalo, no one has ever questioned our right to demand it.

THE QUESTION OF EXPENSE.

Of its value, there is not a shadow of a doubt, in my mind; the results are eminently satisfactory. I believe it is practicable for any class in secondary schools to make at least six field excursions. They need not always occupy the whole day, and they can be made for less than $2.50 all told. In country schools this would be far less, and even without spending a cent.

It is surprising to find the entire absence of complaint on account of expense. The parents, no doubt, are satisfied and pleased with the account given of the trips. And should there be a pupil who cannot afford the expense, a little tact on the part of the teacher will soon arrange something satisfactory.

I believe it is satisfactory, then, to make at least six excursions

as a class each term; out-door work and observation need and must not be limited simply to spring and autumn. Individual excursions should be encouraged and collateral reading recommended for all, of which due credit should be given. There is always something to be observed at all times which has an important bearing on geography, geology, botany and zoölogy, and there is much side reading, and many beautiful tales and myths in prose and poetry, all connected with these subjects.

I cannot believe that so important a branch of science work as field study is neglected. If it is neglected, the person having the class in charge is either ignorant of the pleasure and the great profit derived from such work, or else not in sympathy with the work. For who can look about him, see all the phenomena and facts of nature, all their deep meaning, feel all the profound emotion which stirs the deepest and purest sensations in the human breast and not rejoice in the fact that it his great privilege to be a teacher, and to lead young minds to a fuller realization of the works of God.—*The School Journal.*

SOME EDUCATIONAL REASONS FOR OBSERVATIONAL TEACHING IN ELEMENTARY ASTRONOMY.

By George W. Myers.

Most teachers who have seriously attempted to define for themselves the aims of education admit that knowledge, as commonly understood, is at best but a subsidiary *aim*. This relegates the text-book to a secondary place in teaching. But when the truth of the first statement begins to dawn upon the teacher he is in danger of underestimating knowledge as a *means* of education. The text, therefore, has a legitimate place, even though secondary. No one needs to bear these two facts more clearly and continually in mind than does the high school science teacher. Knowledge as *means* is sound pedagogy, knowledge as end is quite another proposition.

It is indeed well for the science teacher both in the secondary

and in the higher schools at times to restate the aims of teaching in terms of his own science. Too frequently the teacher of the physical sciences is so engrossed with the beauties and revelations of his subject as to fail almost, if not altogether, in this important duty. Even teachers who become text-book writers are guilty, it would seem, of gross delinquency in this respect, when they make their books mere compendiums of their special sciences, or outline-courses for popular reading in these subjects. Prefatory statements of writers of texts in the mathematical sciences to the effect that the purpose of the writer has been to eliminate all demands for the mathematics would seem to argue the author into this same category of delinquents, if indeed it does not impugn his motive as a man of science. It is doubtful whether any physical science can roll up a larger percentage of teachers who fail—unintentionally, of course, but none the less fail—practically to recognize the importance of inquiring into the relative value of various possible methods of presenting truth to beginners than can astronomy. It is believed that this deplorable state of things astronomical, perhaps nowhere so conspicuously and perniciously present as in our high schools, is both a cause and an effect of the general apathy, now happily passing, felt toward the educative value of this noble science.

In the March number of SCHOOL SCIENCE the writer briefly and somewhat crudely presented the reasons for the prevalence of this feeling. In this paper he will briefly state some of the educational principles which have wrought significant changes in school curricula by the introduction into them of physics, chemistry, zoölogy, etc., and which seem to demand a restudy, if not a reconstruction, of the relations of astronomy to the educational series.

Most teachers will agree that education results from self-effort made in accordance with law, and *from this alone.* The pupil makes an effort to remember, and in some mysterious way his memory becomes more vigorous; he makes an effort to determine and his will is thereby strengthened; he puts forth an effort to think, and his power to think is enhanced. This means we can train a pupil to do a thing only through his *own* efforts to do it. No pupil can attain to the ends of scientific study save

through his own efforts to do so. The teacher can be of service in the way of removing obstacles which dissipate his energies and of indicating guiding principles.

This, however, implies a knowledge, at least on the teacher's part, of the purpose of scientific study. It would be easy to prove, though space cannot be taken for it, that the end of such study is to train the student's mind into the mental habits of the investigator. This requires the teaching of enough knowledge for the student's mind to work upon; but makes mental activity toward a definite goal the important consideration to the teacher. It does not demand a bookful of facts unrelated to the pupil. This cultivates the verbal memory only, and that is the one faculty which does not need cultivating. In the next place, let us seek to ascertain what this definite goal must be.

This necessitates the inquiry as to how the trained scientist deals with his materials in the progress of investigation. This is true because so far as the beginnings are concerned the aim of the prospective scientist and of the general student are identical. In other words, let us ask, how does the investigator proceed in the collation and elaboration of his materials and in his reasoning upon them? This is substantially the same as to ask, what is the method of science? This question has been answered so recently and so well by one of the most eminent scientists of our country that the writer ventures to quote the answer here:

"The accumulation of pertinent observations, the classification and generalization of them, the framing of hypotheses from the materials thus obtained, deduction from these hypotheses and comparison of the products of these deductions in every way possible with new facts until substantial certainty is reached—these are the general steps of the method of physical science."*

A little further on the writer from whom the above is quoted, states that a flash of insight may permit an expert to see quickly whither an investigation is tending and thereby enable him to abridge one or more of the steps mentioned, but adds that if an inquirer omit or obscure *a sure starting point* and *a rigid verification* he thereby proves that he is not even a scientific man at all.

*S. A. Forbes, "The Method of Science," *Public School Publishing Co.*

Without observation and classification there can be no science at all.

If, then, we grant that the study of any physical science should predispose the student's mind to this inductive-deductive method of truth-seeking, how can we teachers of astronomy fail to recognize that when we are eliminating entirely, or even subordinating, observational and experimental work with our classes and depending entirely upon the text-book that we are doing just about as good as no teaching at all?

The series of experimental exercises which the writer promised in the March number, and which are intended to bring within easy access of all readers of SCHOOL SCIENCE, who are desirous of putting high school astronomy on a modern basis, the means of doing so, will be begun in the first issue in the fall.

INFLUENCE OF EXPECTATION IN QUANTITATIVE WORK.

BY N. A. HARVEY.

Department of Natural Science, Chicago Normal School.

In the March number of SCHOOL SCIENCE is an article upon "Quantitative Experiments in Chemistry for High Schools," which contains an excellent estimate of the advantages to be gained from quantitative work in chemistry. In illustrating the possibilities of quantitative work, the writer gives some examples of accurate results obtained by large classes. The examples are certainly very remarkable, and the difference between the extreme results reported is very small. Certainly such work must be productive of the greatest benefit to students.

But one circumstance was omitted upon which will depend, in a very great measure, our estimate of the benefit the student derives from such work. Did the students know before completing their work how much they ought to get, or just about what the answer should be? Any one who has studied the influence of expectation upon judgment knows how much it modifies a conclusion. If, in a quantitative determination, a student knows what result he ought to get, he will get that result almost in spite of himself. It is not necessarily something dishonest, but it is

unavoidable. This is true in quantitative chemistry, it is true in qualitative chemistry, it is true in physics, it is true in biology.

The present writer used for some years a very excellent laboratory manual of zoölogy, containing laboratory directions for the study of a perch. It happened to be more convenient to furnish sunfish for class use, which are very similar fish. The laboratory directions indicated that teeth would be found on the palatine bones. Ordinarily about two-thirds of the class would find teeth on those bones, when in fact the sunfish, which was the one they were studying, has no teeth in that situation.

In quantitative work in chemistry, the pupil is likely to obtain a knowledge of the correct answer to a particular problem. He may get it from the teacher, from a text-book, from reference books, or from the note-books of a previous class. If pupils do have such information it takes away a large part, I should say the larger part, of the value accredited to accurate results.

Equally vicious results are met with in biological subjects. When I go into a laboratory and see note-books containing drawings of the objects that the pupils are studying that look exceedingly like pictures in books with which I am familiar, I at once enter an indictment containing the charge of false pretenses. When I see hung around the walls finely executed charts labeled with a pupil's name, and professedly drawn by the pupil from the object, but which are exact reproductions of figures in standard books, I feel that I am in an art room instead of a laboratory, or that there is need of conversion on the part of some one. Of course the pupil can find all the mouthparts of a crawfish if he knows what they are beforehand, what they look like, and the order in which they come, and especially if he works with a picture or mounted specimen before him. That is not the question. Can he determine for himself the number, kind and arrangement of the mouthparts from the crawfish alone, without other assistance? That will constitute a measure of his power, and a promise of future success.

It is particularly the province of scientific subjects to make the student independent, self-reliant, and capable of seeing things as they are, and not merely as he thinks they ought to be, or as some one else says that they should be. If science fails to do this

it fails to accomplish a large part of the purpose for which it is introduced into the curriculum.

It is the old story of the pony in Latin and the key in arithmetic and algebra. Teachers of Latin and mathematics have got beyond the stage of the pony and the key. I do not say that teachers of science have not, but some things that I have seen leads me to suspect that this touches upon the weakest spot in the science teaching of even our best high schools.

The only method I know to avoid the obtaining of information in what I consider an illegitimate way, is to start right with a class and cultivate the proper spirit toward the work. I know that the proper spirit can be cultivated so that pupils will not seek information about their experiment except from the experiment itself, and that the effect upon the character and intellect of the pupil is vastly superior to that which results from the usual method.

THE MODERN PRESENTATION OF BOTANY.

By A. M. Ferguson.
Instructor in Botany, University of Texas.

Botanists are interested in the advancement of science, whether it be by encouraging investigations in new fields or by the diffusion of knowledge already accumulated. The latter may be secured by popular lectures, magazine articles, etc., but the most thorough, useful and substantial advancement is begun in our public schools. The school science teaching, then, merits our earnest attention for this reason. In advocating higher standards of science it may be said for the non-scientific that it is not for science's sake, but for the school's sake. No science is an end in itself, and the advancement of science is not the question of greatest moment. "Instruction in any subject should develop a capacity for thought and conduct and no scientist wishes to shirk his share of responsibility in training for good behavior and good citizenship. If he has not this faith his right to spend his time in the advancement of science becomes a matter of question. * * * From the standpoint of its effect upon character and

upon citizenship the investigator has a direct interest in the nature of the instruction given to boys and girls whose education ends in the public schools. His greater knowledge imposes upon him the duty of helping to shape this instruction aright." This has been recognized and heeded by several eminent American botanists in the last few years. More than a half-dozen elementary text-books have been put upon the market in so short a period, representing so many schemes of presenting botanical science to the beginner. In passing upon the schemes proposed we should keep clearly in mind the science and the educational value of the science *per se*.

Botany has much in its favor as a distinctly cultural study. It also has that other value which all school studies should have, to wit: practical value when applied to every-day affairs, or, as the Englishman says, "getting along." Whatever may be said of the "scientific method" in the school-room and in business, may be said of botany. It is not an easy task to discuss a scheme of presenting the elements of a science without repeating much that may be said for the sciences in general, especially the biological sciences.

The educational value of a course in botany will depend as much upon the spirit and individuality of the teacher as upon the method of presentation. While the time allowable for such courses is necessarily limited they should be coördinate with the other sciences, and the technical knowledge, so far as it enters into the educational process, should be exact, correct and satisfactory to the specialist. In such a course it is neither how much nor how well scientific knowledge, *per se*, has been imparted to the student, but how much stern but agreeable mental training has the study afforded. It should develop in proper coördination the three most important mental faculties—observation, comparison and deduction.

Botany does not mean the "analysis and naming of flowers" alone, nor does it consist in pressing a few fragmentary specimens in an old geography and calling it "an herbarium." The ultimate question in botanical science is, "How came plants to be as they are?" and takes in not only the genesis and evolution of the plant world, but more especially the relation of vegetation

to things in general. "Botany," says Professor Goodale, "is the science which attempts to answer every reasonable question about plants"—*i. e.*, how they grow and are grown, when and what they came from, their habits and peculiarities and the relation they bear to the general economy of nature. But you cannot treat the science comprehensively in an elementary presentation. The question, then, that has received such various answers in the text-books referred to is this: "What kind or part of botany will give the best returns for the time and energy expended," or, as Professor Ganong puts it, "What phase of botany best develop the scientific instincts; and what knowledge of plants is educationally most useful to the average student?" All the answers have been synthetic; that is, the courses in botany are planned to do for the students of the vegetable world just what physiography is doing for the student of the land,—to demonstrate the factors determining its present construction. The factors are more complex for the vegetable world and cannot be answered in an elementary course, yet the science and the instruction have this trend. How much broader is this than the "morphology and analysis" so much in vogue not many years back?

In conclusion, I wish to commend to every teacher Professor Ganong's "The Teaching Botanist." In addition to a quite suggestive discussion of botanical pedagogics and valuable "shop" talks, an outline is given for a comprehensive course in botany admirably suited to certain conditions. Where time and laboratory equipment allow, a different order of treatment seems to be advisable.

The Lavoisier Medal.—The French Academy of Sciences has voted to distribute annually a gold medal in memory of Lavoisier. M. Paulin Tasset is preparing the die for the medal and has taken as a model the well-known medallion by the sculptor, David d'Angers. The name "Laurent Lavoisier" will be under the profile, and on the back will be inscribed the words, "Institut de France, Académie des Sciences, Medaille Lavoisier." The project is in the hands of M. Berthelot.

A HIGH-SCHOOL LIBRARY FOR PHYSICS.

By H. N. Chute.

No one questions the truth of the proposition—every high school should possess a carefully selected library for the use of its pupils. That this is true is shown by the fact that the majority of such schools are today equipped with libraries of reference books, more or less complete, and are adding to them as ways and means are provided. In most cases our schools are under the management of men of classical training and tastes and as a consequence the books that have been selected for the libraries have been very largely, if not wholly, in the line of history and literature. Within the last few years the sciences have been demanding a place in the educational curriculum with a persistence and a force of argument that would brook no denial. They have come asserting their ability to give a mental training equal in every respect to that produced by the time-honored classics. Nor have their claims passed unheeded, notwithstanding the oft repeated assertion of their opponents that "they are without culture value." Against much opposition the sciences have made for themselves a place in the curriculum of our secondary schools and are today demanding equal rights with literature, language and mathematics. The advent of the Laboratory Method in science instruction has wrought a wonderful revolution in the opinions of educators as to their educational value, so much so that some have come to believe that it is only through the test tube, the caliper and the balance that real knowledge can be gained. Under the classical régime in our schools, we did little else but study books and worship their authors. The Aristotelian Method reigned supreme; books were our authorities for everything, nothing was tested, nothing tried. Within recent years the Baconian Method has rushed to the front with such a din and persistent shouting that many of us have quite lost our heads, or at least there is danger of it, and we proclaim on every possible occasion that "there is no source of knowledge but experiment," and that "by its means alone can we learn anything new or cer-

tain." It is the purpose of this discussion to call in question this new dictum and to maintain another proposition, to wit, that books are as much the tools of the student of physics as are his calipers, his resistance box, or his spectrometer; that if he is to know much of its laws, the history of its development and its wonderful possibilities, he must look beyond his own meager investigation; that if he would have a well rounded-out knowledge of the physical world, he must combine library and laboratory.

The student of physics must learn how to use books, how to search them for information on the various questions that come up in his studies, just as he learns how to observe, how to experiment, how to discuss and analyze data obtained and extract from them their hidden meaning. It is a great gain to learn that information on this electrical fact or on that optical phenomenon can be gleaned from many books, where each writer has expressed it in his own peculiar way; this one bringing out one shade of meaning and that one another, each supplementing the other and rounding out one's knowledge to greater fullness and clearness.

It has been said that the great end of all education is to make people able to educate themselves. If this be true, and true it undoubtedly is, that school will be most helpful to that end whose library is well filled with carefully chosen books covering all departments of learning, whose students are trained in the wise and proper use of these books, having studied them much as the skilled mechanic does his tool chest, to the end that he may know where to find things when needed, and how to use them when found to the greatest advantage. For after all, does not the education that has real value consist in great part of having learned the places where information can be obtained? Does the astronomer remember his intricate formulæ, the chemist his analytical tables, and the physicist the outcome of every experiment which has been tried? Each is content if he but know where such information can be found when needed, provided his training has been such as to enable him to apply it correctly to the work in hand.

It would seem that of all students, the one of physics most

of all needs books. The beginner should have them to add flesh, blood and color to the dry bones of the school text book; to add interest to the subject by bringing his mind more fully in contact with the wonderful store-house of useful and attractive facts lying dormant in these treasure houses. He should read the biographies of some of the great scientific worthies. No boy can read the life of the immortal Faraday without feeling a healthy moral glow within his very soul and without experiencing a strong desire to imitate in some small way that sweetest, greatest and withal most modest of modern thinkers. He will also find it very helpful to read a little of the history of physics. The difficulties that the students of today encounter in the study of this subject are the same ones with which the master minds have restled; and it will often prove true that the best way for the student to meet them is the one discovered by the thinkers and workers of many years ago. It is an encouragement for the student to know that what he finds "hard to learn" is what has perplexed learners ever since the days of Thales, and it will be of great value to him to know of the patience and persistence of these seekers after truth and knowledge, of the self-denial and devotion exercised in their pursuit of facts and truths which they had reason to believe existed, but were unrevealed, of their many failures and final success in reaching the goal of their ambitions. It gives him courage to "up and at it," for he feels that his failures are not necessarily due to his native dullness, but are inherent in the subject itself.

Not only will the history of physics be helpful in surmounting difficulties, but its study will add interest and zest to the work. No boy or girl can read the story of Guericke and his quaint air-pump, the amusing episode of Cunaeus and his Leyden jar, the controversy between Galileo and his Aristotelian opponents, the discovery of atmospheric pressure by Torricelli and a hundred other interesting stories that sparkle throughout the pages of science, without having his scientific appetite whetted for further reading and for further investigation, to say nothing of the help to memory, and to the reasoning faculties in the better understanding of the principles laid down in the text books on the subject.

To make the most of this reference library for physics, the teacher must know its contents as thoroughly as he knows his laboratory, to the end that he may refer his pupils to the proper sources of information and guide them intelligently in their reading. He should have read these books with this end in view. And in doing so he will find himself unexpectedly rewarded in the greater facility he has acquired in explaining difficulties, in the ability gained to approach them from various sides. Every teacher knows that an explanation that may be clear to one student is not always equally clear to another, and that it is necessary to resort to many expedients and devices to make things clear to all.

As a nucleus for a Library for Physics I would suggest the following books, those marked with an asterisk being given the preference:

BIOGRAPHY:

*Michael Faraday. His Life and Work. *S. P. Thompson.* The Macmillan Co.
*Pioneers of Science. *O. J. Lodge.* The Macmillan Co.
Humphrey Davy, Poet and Philosopher. *T. E. Thorpe.* The Macmillan Co.
Jas. Clerk Maxwell and Modern Physics. *R. T. Glazebrook.* The Macmillan Co.

HISTORY:

*A History of Physics. *F. Cajori.* The Macmillan Co.
*A Popular History of Science. *Robt. Routledge.* George Routledge & Sons.
A Short History of Science. *Arabella B. Buckley.* Appleton & Co.
History of the Inductive Sciences. *W. Whewell.* Appleton & Co.

GENERAL PHYSICS:

*Recent Advances in Physical Science. *P. G. Tait.* The Macmillan Co.
*Conservation of Energy. *Balfour Stewart.* Appleton & Co.
*Natural Philosophy. *A. P. Deschanel.* Appleton & Co.
General Physics. *Hastings* and *Beach.* Ginn & Co.
Principles of Physics. *Alfred Daniell.* The Macmillan Co.
*University Physics. *H. S. Carhart.* Allyn & Bacon.

MECHANICS:

*Elementary Mechanics. *O. J. Lodge.* W. & R. Chambers.
*Mechanics and Hydrostatics. *R. T. Glazebrook.* The Cambridge University Press.
Science of Mechanics. *E. Mach.* The Open Court Publishing Co.
Mechanics. *R. S. Ball.* Holt & Co.
Dynamics and Hydrostatics. *A. Pinkerton.* Blackie & Son.

HEAT:

*Elementary Treatise on Heat. *Madan.* Longmans, Green & Co.
*Theory of Heat. *J. C. Maxwell.* Longmans, Green & Co.
*Theory of Heat. *Thos. Preston.* The Macmillan Co.
*Heat a Mode of Motion. *Tyndall.* Appleton & Co.
Growth of the Steam Engine. *R. H. Thurston.* Appleton & Co.

ELECTRICITY AND MAGNETISM:

*Electricity and Magnetism. *S. P. Thompson.* The Macmillan Co.
*Modern Views of Electricity. *O. J. Lodge.* The Macmillan Co.
*Primary Batteries. *H. S. Carhart.* Allyn & Bacon.
Dynamo-Electric Machinery. *S. P. Thompson.* E. & F. W. Spon.
Arithmetic of Electricity. *T. O'Connor Sloane.* Munn & Co.
Electrical Rules and Tables. *Monroe* and *Jameson.* Chas. Griffin & Co.

SOUND:

*Sound and Music. *J. A. Zahm.* A. C. McClurg & Co.
*Sound. *John Tyndall.* Appleton & Co.
Theory of Sound. *P. Blaserna.* Appleton & Co.
Sound. *Poynting and Thomson.* Chas. Griffin & Co.
Sound. *A. M. Mayer.* Appleton & Co.

LIGHT:

*Theory of Light. *Thos. Preston.* The Macmillan Co.
Nature of Light. *E. Lommel.* Appleton & Co.
*Polarization of Light. *W. Spottiswoode.* The Macmillan Co.
*Light. *Lewis Wright.* The Macmillan Co.
Spectrum Analysis. *H. E. Roscoe.* The Macmillan Co.

MISCELLANEOUS:

*Soap Bubbles. *C. V. Boys.* E. & J. B. Young & Co.
*Experimental Science. *Geo. M. Hopkins.* Munn & Co.
*Time and Tide. *R. S. Ball.* E. & J. B. Young & Co.
Lectures on Scientific Subjects. *J. F. W. Herschel.* George Routledge & Sons.
Fairy Land of Science. *Arabella B. Buckley.* Appleton & Co.
*Physical Tables. *Thomas Gray.* Smithsonian Institution.
Common Sense of the Exact Sciences. *W. K. Clifford.* Appleton & Co.
*Properties of Matter. *P. G. Tait.* A. & C. Black.
*Matter and Motion. *J. C. Maxwell.* Van Nostrand & Co.
Flame, Electricity and the Camera. *Geo. Iles.* Doubleday & McClure Co.

ZOÖLOGY IN SECONDARY SCHOOLS.

BY MAURICE A. BIGELOW.
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(*Concluded from page 72.*)

The college and secondary courses under such a system would be supplementary with no repetition, and in the end those students who take both college and secondary courses in zoölogy may have a broad view of animal structure, function and life. There can be little doubt that the course in natural history is valuable in preparation for the more advanced work in the college, but it may well be doubted whether such a course is altogether the best for secondary work when considered from the standpoint of liberal education. In the omission of all reference to the general facts of internal structure and functions, has not the reaction from the purely morphological course been too extreme?

In secondary work the important physiological side of zoölogy has received but little attention, as compared with that given to natural history and morphology. In the types of elementary courses which have been discussed, there is often some mention of comparative physiology, or some observational work on responses to external stimuli; but, on the whole, physiology can hardly be considered as one of the characteristic features in the usual examples of either of the two types of courses. The fundamental physiological relations of the internal machine of the animal body have been neglected almost universally, but they should be as characteristic as any other feature of an elementary course.

The importance of interpreting the activities of the human body from the comparative standpoint seems sufficient reason for advocating the consideration of the fundamental principles of physiological action in connection with the study of elementary zoölogy. Experience has convinced the writer that there is no more profitable study for secondary pupils than the physiological side of animals. No other phase of zoölogical study arouses a deeper interest and appreciation or is more spontaneously applied by the pupils in connection with study of their own life activities. It is scarcely necessary to offer a stronger reason for including such study in an elementary course.

Summarizing the review of the ordinary types of courses in elementary zoölogy, we must recognize that there are important features in both the morphological and the natural history courses, but when standing alone each is extreme. Each has fundamental facts and ideas which are of interest in liberal education, and also in each there are numerous details which have only special or technical value. From this follows the suggestion that the essential and valuable features of the two courses may be selected and incorporated into one. But this is not sufficient, for it has been pointed out that the very important physiological side of zoölogy deserves attention, which neither of the ordinary courses gives. The course, then, which will meet the demands of liberal education should be a study of animals from the combined aspects of the fundamentals of morphology, physiology and natural history. This statement must not be misinterpreted. To a naturalist each of the three fields is much too wide even for a lifelong study, but it must be kept in mind that the problem in secondary work is to give the pupils the most valuable ideas of animals, and the widest view of animal life. The demand of liberal education is for a broad attitude of mind toward animals, and good general ideas of the fundamentals of zoölogy. The vast masses of facts of detail which interest the naturalist must be reserved for special study by those who have time and special reasons for advanced study of the science.

Among the minor problems involved in arranging a course combining the essentials of the various phases of zoölogy, the first and most difficult one is concerned with the inclusion of physiological work in the course in elementary zoölogy. By physiological the reference here is directly to the essential processes in the general metabolism of the animal body, and the term is not limited to the mere work of observing a few movements and responses to stimuli which constitutes the great part of the so-called physiological study in many elementary courses. The study of fundamental physiological processes obviously admits of very little practical work in a direct line, and the facts must be presented by text-book and teacher. But the morphological basis for such can be strictly practical, and a logical presentation should lead the pupils from observed facts to conclusions, so that the

discussion of the subject of general physiology of animals may be of far more value than a mere didactic exercise.

The usual objection to physiological work in secondary schools is that the subject cannot be presented by a strictly laboratory method. But how much physiology does the advanced student get directly from his own laboratory studies, as compared with what he accepts on the authority of teacher and books? In how many colleges is the laboratory method *strictly* and *exclusively* applied in biological teaching? The evident answer to these questions shows how weak is the argument that only strictly practical work should be included in elementary zoölogy in secondary schools.

In combining physiology with the morphological work of the course in zoölogy, it is important that the two phases of study be closely related throughout the course. The few text-books and teachers' outlines which merely suggest a tendency toward a union of the two phases of zoölogical study seem to show that in general the attempt is to teach physiological ideas in the form of abstract generalizations with little of concrete application to particular animals which are studied morphologically. Sometimes these generalized principles of physiology are introduced before the pupils have progressed far in the practical study of animal structure, but more often after the completion of a purely morphological course. Such a method of presenting the principles apart from concrete application is open to serious objection. In the light of experience it may well be doubted whether such presentation gives secondary pupils a clear conception of general life-activities. A physiological principle may be formulated in a generalized way, and as such may be memorized by the pupils; but that they do not grasp the ideas involved is shown by the fact that they usually fail in application when concrete cases are placed before them. Every zoölogist knows in personal experience how indefinite and unsatisfactory are the ideas gained from reading generalizations if he cannot easily recall and connect them with the specific underlying facts. In order to appreciate the attitude of the elementary pupil, it is only necessary to recognize the fact that even at the close of a half-year course the pupil has not the definite remembrance of the details of the structure which are neces-

sary for concrete illustration and application of the principles of physiology. In order to give the clearest possible conception of physiological principles it is essential that structures and functions should be studied in their natural relations. The principles of physiology should be introduced with the first animal which is studied morphologically, and each principle as introduced should receive concrete application. The study can easily and quickly be made comparative as successive types of animals are taken up, and finally such specific and comparative studies may be made to lead to a direct application of the principles of comparative physiology to the activities of the human body.

Another minor but important problem which demands consideration is the much discussed question regarding the value of unicellular versus multicellular animals as types for the introductory study. Shall a course in elementary zoölogy be synthetical, beginning with unicellular animals and then progressing toward the more and more complex forms, or shall the study be analytical and, beginning with a complex multicellular animal, lead down the scale of structural and functional complexity to the simplest forms? The first named order is the one usually followed, and it is defended chiefly on the ground that it corresponds with the logical order in the development of complexity in the animal series. However much weight this may have in college work, it is doubtful whether the generalizations involved in considering animal structure and function synthetically are grasped by immature beginners in secondary schools. Moreover, an appreciation of the relations underlying the great idea of organic evolution does not necessarily depend upon a study of animals taken in the order of increasing complexity. It appears then that the argument for logical order must be regarded as insufficient.

The difficulties involved in an attempt to grasp the meaning of the structure of a protozoön are greatly complicated by the compound microscope. By use of the microscope is not meant mere mechanical manipulation, but especially accurate interpretation—a far more difficult thing for most beginners. Very many teachers consider this alone sufficient reason for *not* beginning the course of study with a microscopic form, for if the intro-

ductory type is a multicellular form of considerable size, the use of the microscope can be learned gradually in connection with the gross examination.

The advantages of beginning the study of structure with an animal about which the pupil knows something, or at least can learn with the aid of no more uncommon apparatus than the eyes, were well stated by Huxley many years ago after he had learned by experience the great disadvantages connected with beginning zoölogical study with a microscopical animal. Many teachers in colleges have since expressed agreement with this opinion of Huxley. As applied to elementary zoölogy in secondary schools where the pupils are undeveloped, the arguments advanced by Huxley are of greater weight than when applied to college work. Pupils encounter few serious difficulties in an introductory study of the important points of structure in a complex animal. The supposed difficulties arise largely when detailed study is attempted. The general relations and the *essential* structure of organs are in the very beginning readily determined and comprehended by very young pupils.

The same arguments hold good from the physiological point of view. Every pupil knows something about the functions of his own body, and it is easy to grasp the fundamental principles of physiology when concretely applied to organs of an animal in which there is considerable physiological division of labor. It is evident that this must be a decided gain when compared with beginning physiology with a unicellular animal where all functions must be thought of abstractly in connection with a single cell. Beginning with the physiology of a multicellular animal, and considering a series of simpler forms which lead down the scale in division of labor, the pupils can understand every step of the way, and in the end will have a clearer idea of the functions of both one- and many-celled forms in their relation to the great principle of physiological division of labor.

The conclusion must be that so far as the work of secondary schools is concerned there is very little to be said in favor of introducing the course in elementary zoölogy by the study of a unicellular animal, while there is much in favor of beginning with the multicellular form. The simplest animals appear to be, after

all, the most complex from the young beginner's standpoint. More than this, almost everything which is supposed to argue for a logical and synthetical order of study depends upon generalizations which are not appreciated by the average secondary pupil. The experience of large numbers of teachers seems to support strongly such conclusions.

In preceding paragraphs it has been advocated that elementary zoölogy should include the most important facts and ideas of general anatomy, natural history, and the essentials of physiology. It has also been urged that physiological study should be intimately associated with morphological study from the very beginning of the course. Finally, reasons have been given for regarding multicellular animals as most favorable for introductory work which is to involve any of the above aspects of zoölogy.

Depending directly upon the foregoing conclusions, the central idea of the course in elementary zoölogy which is outlined in this paper* is that of an introductory study of a complex animal examined from the several view-points of zoölogy. Such a study includes the most important facts of anatomy, histology, embryology, classification in connection with the near allies of the introductory type, distribution and ecology, general fundamental principles of physiology, habits of life, and life history. Again it may be necessary to remind the reader that this is not to be misunderstood as meaning that any one of these phases of study should go far into details. The question—What is essential for liberal education?—should be strictly applied in eliminating all that has no good reason for inclusion in the course. The writer's interpretation of what may be considered valuable in this connection will be best represented by a detailed outline of such an introductory study of one animal, and this is given in the outline of the course.*

This method of introducing the study of zoölogy by a broad biological study of a single animal has long been favorably received in college work. It is unnecessary to show here that the important facts of animal structure and function can be well presented and illustrated by study of a single animal. Huxley's classical work on the crayfish, as an introduction to the study of

*In *Teachers' College Record.*

zoölogy, gives sufficient defense to this method; and Sedgwick and Wilson have successfully applied the same idea to the earthworm. These two books have suggested the line of work which is here advocated for elementary zoölogy. Both the work of Huxley and that of Sedgwick and Wilson are far too advanced and technical for elementary pupils, but it will appear in the general plan of the outline that these books have contributed many suggestions.

Such introductory study as has been suggested can be completed within the first five weeks of a half-year course, leaving eleven or twelve weeks in which to have a broad survey of the animal kingdom. This will be criticised on the ground that it gives too much attention to a single animal; but it will appear in the outline that most of this time is devoted to zoölogical principles capable of wide application, and which are illustrated by the careful study of a single animal. After pupils once grasp these principles, application to animals which are studied later is easily and quickly made. This method of introducing the study is designed to give pupils general ideas of the structure and activities of one animal which will aid in appreciating and interpreting any other animal. It is also intended to give intensive study of the fundamental principles of anatomy and physiology, and thus lay a foundation for a deeper acquaintance with many other animals representing important groups. Accepting the view of those naturalists who consider studies in natural history very important in liberal education, the aim is to prepare for them by including in the introductory work many of the most important topics from the other phases of zoölogy, so as to give a broader view of animals and their life than natural history alone can give. In short, the general aim is to lay a foundation which will make later study of animals, from whatever standpoint, more interesting and more intelligible, because there is included in the foundation work those great principles of animal structure and function which are of wide interest and application.

The writer is convinced that the broad view of a single animal and of some of the general principles of zoölogy, gained from the introductory study, exert a marked influence on all subsequent study of animals. Pupils with such preliminary training may be

required later to study some animals from a limited point of view, for example, natural history or morphology, but their general ideas of one animal from the various points of view lead them to think of all animals as presenting illustrations of the various aspects of zoölogy. The pupils, as a rule, are eager to study every animal brought into the course as thoroughly as the introductory type was studied—that is, from the various aspects of zoölogy. Although time will not allow such extensive study of more than one form, there is great value in such an attitude of mind with its broad outlook and interest in the various phases of animal life. This fact is mentioned here partly for the purpose of showing that interest is not lost by extended introductory work, as some critics have already urged on *a priori* grounds. Experience indicates that there is a gain rather than a loss in interest.

In conclusion it is claimed that upon a broad introductory study of one multicellular animal it is possible to base a course which combines the most valuable features of the various courses usually presented in secondary schools, and that it is possible at the same time to give as good training in scientific observing and thinking as can be done with any other course. Moreover, such a course gives a view of animals and animal life which is broader and more valuable from the standpoint of liberal education than that given by the ordinary courses which are limited to the viewpoints of either natural history or morphology. This claim is based upon the fact that such a course includes the fundamental principles of physiology in the natural relations with morphology and natural history, the importance of which relation has been discussed elsewhere.

It is not claimed that pupils who follow such a course know much about the details of comparative anatomy in a series of animals, or understand the intricacies of physiological processes, or that they store up a mass of facts from natural history; but from the standpoint of liberal secondary education stores of facts are not needed so much as broad general ideas, and an acquaintance with and interest in animals and their life.

SOME EXPERIENCES IN EQUIPPING THE LABORATORY.

By W. E. Bowers.

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While the more elaborate and expensive pieces of apparatus must always be made by skilled specialists, and supplied by the dealer in apparatus, wonders can be accomplished in the way of "home-made" apparatus by the enthusiastic teacher and the ingenious pupil. But these rude devices and fantastic make-shifts are fast giving way to apparatus that is substantial, durable and accurate, and that requires the application of skilled labor. It is the purpose of this paper to suggest a means of securing apparatus of this character at a comparatively small outlay, and to make a modest plea for the policy the writer has found thoroughly successful during the past three years.

While there is everywhere a gratifying tendency to add to the laboratory equipment, too many schools, especially small schools, spend their money for a few pieces of expensive factory-made apparatus, and then worry along with one micrometer and one vernier caliper, one balance, two pneumatic troughs, and three ring stands, in a laboratory where a dozen or half-dozen of each is necessary for convenient work; or they put the money into illustrative apparatus, and do without many things necessary for individual, especially quantitative work. It is, however, the conviction of the writer that, with the exception of chemicals (which may be bought through the drug store), rubber goods, glassware, and the elaborate pieces of apparatus, the laboratory may be well equipped, and very little money sent outside the city limits.

The objection may at once be raised that there is no one to do this kind of work; yet this objection usually soon disappears upon earnest and enterprising inquiry. Few towns large enough to have a high school, are without a gun shop, a bicycle shop, or a foundry, where some workman may be found who is able and willing to do all kinds of metal work, if the design is furnished by the teacher. Often this workman is a skilled machinist; occa-

sionally he proves to be an immigrant from Europe, where he has had training in the very work required. Not infrequently he is a graduate of the local high school, or a college student, well versed in science, able not only to make, but also to design, apparatus, easy to interest in the work of the high school, and glad to be of service to the teacher and the school.

Such workmen can furnish, for practice in measurement, hardened steel rods, stamped and numbered, and turned so true that they will bear a micrometer test in any dimension, at a few cents each. An oxyhydrogen blowpipe, made after the drawing given in most texts, will cost less than a dollar. If desirable, it may be made so as to be taken apart to show the construction. Bunsen burners can be had for about the same price, or even less; and five or six dollars will get a dozen ring stands, each with a 20-inch rod and three or four welded rings, enameled throughout.

The best bargains and the best apparatus are in specific gravity balances. Only a faithful and a first-class workman can be trusted with the difficult task of making, adjusting and balancing so delicate a piece of apparatus. The writer has had three sets made at prices ranging from $8 to $18 for half dozen lots. Although the balances of the first lot were too small and too sensitive for the best results (easily sensitive to the graphite used in writing name and address), they were fairly satisfactory, and those of the last lot are highly so (experience has improved the design).

Each has a cast-iron base of neat design, and standard of small bicycle tubing (steel, 12 inches high), both enameled. The sliding telescope rod is of cold-drawn steel, the block for the bearings is sawed and drilled from steel bar and hardened; the 10-inch beam, knife-edges, pivot bearings, pointer, scale and beam arrester are likewise of hardened steel. These parts are well finished and have a polish equal to that of a good grade of shears. The pans are of spun brass, suspended on spring brass wire, of two heights, with hooks. They are bronzed and look fairly well; the *appearance* of the pans is the only particular in which they do not excel factory-made balances of medium quality.

These balances were made in the gun shop in this place and

are strong, durable, sensitive to one centigram, and equal in utility to the factory-made balances listed at much higher prices. By actual test they compare without discredit, at least while new, with certain balances which were listed at $7, $8 and $16 each.

The same workman could, if desired, make compasses, dividers, simple calipers, pendulums, models of pulleys, ring and ball apparatus, siren disc, and many other similar instruments, even a whirling table, screw press, hydraulic press, and model of steam-engine—all at reasonable prices. Of course, this policy may be carried too far; most electrical apparatus, sets of metric weights, etc., are best purchased from a dealer.

Several arguments may be urged in favor of this policy. Strange as it may seem, quality of apparatus is an object but in few cases; economy of expenditure is the main thing to be gained. Then, too, an order of this kind is always a patronage of home industry, a reminder that the high school is not a dead weight on the community, and it always tends to attract the more cordial support of public-spirited citizens, as well as of the business men, workmen and school officers.

In a series of articles to follow, the writer will give working drawings and specifications for the construction of a number of pieces of apparatus that his experience has shown can be made satisfactorily by any skilled mechanic.

WHAT CAN BE DONE WITH A SUNBEAM.

By A. E. Dolbear.

Professor of Physics, Tufts College.

Everybody knows of the magic lantern and its possibilities in a school-room, but many do not know what can be done with a sunbeam and a few dollars' worth of proper fixtures in the same place. Let me indicate briefly how little is really needed in order to obtain pictures which rival those from a costly lantern and an electric arc light.

I will assume a school-room into which the sun will shine

directly and having the windows provided with dark colored curtains. A small portable mirror, six or eight inches square, placed on the window sill will permit one to direct its reflected beam to any part of the room all the time the sun shines in that window. Direct the beam across the room so as to fall as a bright spot about midway between floor and ceiling. Next take a double convex lens, about four inches in diameter and one foot focus, and hold it two or three feet from the mirror in the path of the beam. A great disc of light will now appear on the other side of the room. A wooden retort holder will serve to hold the lens in this position, and now if a key or pencil or finger be placed between the lens and the mirror an enlarged and inverted image of the object will appear on the wall opposite, and the outlines may be well defined by moving the object in the beam toward or away from the lens. If the opposite wall be a white plastered wall it will serve well for a screen. If not, a square of white sheeting ten quarters wide or more can be hung there, and removed when not needed, if not on roller. If the lens so used is unmounted, there will be more or less direct light in the middle of the disc, and this may be excluded by fixing the lens in the middle of a board a foot square, through which a hole has been made a little smaller than the lens, to hold it and permit the light to go through. Another retort holder may have fixed in it any lantern transparency or other object to be shown on the screen. The mirror, the mounted lens and the holder for the transparency can be set upon a stand at the window, and its curtain drawn down only so far as to permit the sunshine to fall upon the mirror. Of course, the other curtains may be quite down. But with sunlight one may have bright pictures upon the screen when there is enough light to see easily to read by. The size of the picture on the screen will be equal to the distance of the screen from the lens divided by the focal length of the lens. Thus, if they be thirty feet apart and the lens focus be one foot, the enlargement will be thirty times, so that a transparency three inches square will be seven and a half feet square on the screen.

As described above, the mirror and the lens are but two or three feet apart, but if it be inconvenient to have it thus, the lens can be on the teacher's desk or other convenient place, and a

second adjustable mirror will direct the beam where it is wanted and used the same as before. As the sun slowly moves it is needful to readjust the mirror every minute or two, but having once got the beam and lens in line with the middle of the screen these should not be changed, but only the mirror, so as to shine fully upon the lens in its fixed place.

Diagrams drawn upon smoked glass, or scratched upon thin sheets of mica or gelatin, show well and are easily prepared, while the transparencies made for the lantern are admirably shown.

If the object to be shown be so small that higher magnifying power is needed to be properly seen, such as microscopic things, minerals or insects, there will be needed an additional lens, which may be a common pocket magnifier, a botanical glass, held in the beam of the larger lens near its focus, so all the light from the latter goes through the small lens. The small object, say, the leg or wing of a fly fixed upon a strip of glass, may now be placed between the lenses and near the smaller, and then slowly moved toward the larger. The image will be sharply defined when at the proper distance, and its magnitude will be approximately as in the former case, the distance of the screen divided by the focal length. If the lens focus be one inch and the distance thirty feet the image will be magnified 360 times and a fly's leg one-fourth of an inch long will appear more than seven feet long. A glass tank for holding animalcules may easily be made with two strips of glass four inches long and an inch wide, separated from each other by half a small rubber ring, so as to make a semi-circular pocket and all held together by rubber rings. This will hold, for instance, two or three drops of vinegar, and such eels as chance to be in it may show as so many snakes two or three feet long, wriggling over the screen.

Once more, an object held in this diverging beam from the small lens will show in enlarged outline upon the screen; so apparatus and figures too large to be projected in the ordinary way, and too small to be easily seen at a distance in their details, may be readily shown thus. For instance, an electroscope and its slightly diverging leaves.

There are multitudes of things and phenomena that may thus cheaply be projected. The apparatus needed are the mirror, the

lens and screen. Such a lens as I have described can be had for a dollar and a half, and a carpenter can fit it into a board. A good botanical glass can be had for fifty cents and clamps for holding such things for a quarter of a dollar a piece.

Books are to be had describing experiments of this kind. And if one can afford it, he can get a good porte lumiere for fifteen dollars, which will be more convenient, but not more efficient.

QUANTITATIVE CHEMICAL EXPERIMENTS FOR BEGINNERS.

By G. W. Benton.

On page 15, School Science for March, 1901, Dr. Newell states the fundamental aim in using quantitative experiments to be "to teach the pupil accuracy, confidence, cleanliness, and a profound regard for exact experimental work." On page 13, of the same article, he further says:

> By quantitative experiments we do not mean "research work," nor the simpler determinations which are included in the customary course in quantitative analysis in colleges. Such work cannot be transferred bodily to a high school. It is just here that some teachers and authors have made a fatal mistake, and they are partly responsible for the negative attitude assumed by some secondary teachers toward exact work. Quantitative experiments intended for beginners should possess those elements which characterize all profitable experiments. For example, they should demand only the average degree of manipulative skill. Skill comes by constant, protracted labor. It is an evolutionary product, and is not possessed by beginners, etc.

In the opinion of the writer, the above is sound doctrine. In emphasizing these two statements there is no intention to detract from the merits of the remainder of Dr. Newell's excellent article on "Quantitative Experiments in Chemistry for High Schools." They are quoted simply as an excellent text for the discussion which follows.

The question of quantitative experiments in the first course in chemistry has been under examination in the Shortridge high school for two years and more. The attempt was first made to adapt the experiments proposed by some writers more zealous than wise, who thought the way to reach the child with the

quantitative idea was to reduce to the desired dimensions the typical college experiment, by a process of eliminations, regardless of the fact that the part left was practically a skeleton only, if not merely a few dry bones.

It is needless to say to those familiar with the situation that the first experiments failed. As a result, it became necessary to make experiments for ourselves which should, to a degree at least, meet the prevailing conditions, which the earlier attempts had forced into view. The most apparent of these conditions were:

First, The experiment must involve the simplest manipulation possible.

Second, The details of procedure should be minutely and clearly stated. Nothing must be taken for granted.

Third, Every experiment must be so chosen that the ordinary as well as the very bright pupils can work it out for himself, unassisted by the teacher, as soon as the questions involved are understood.

Fourth, The points of the experiment must be emphasized in concluding remarks.

Fifth, Results must come very close to theory, and sources of error must be easily recognized.

Sixth, The time element must be carefully considered.

These and other conditions of less importance governed the general development of the experiments which grew up one at a time, through various revisions, as the experiences and difficulties of the pupils were encountered. The first series prepared involved twenty-one experiments, which have since been reduced to fourteen, as the limits of the half-year will hardly permit more without seriously interfering with the general descriptive work. These experiments are worked individually and not by the class together. As a consequence, while the quick pupils may complete all of them, the slower pupil, while not working so many, is enabled to do well what he does do. This plan has a two-fold advantage; viz.:

The quicker pupil loses no time in waiting for the slower, and a suggestion from the teacher generally shows the former as well as the latter how two things may be carried on at once, thus saving laboratory time. As it would appear, this is the weak

point of most of the quantitative laboratory instruction in high school courses in physics. This plan means work for the instructor, but it also means "high pressure" for the members of the class.

As a result of the work done to date along the line of the preparation of these experiments, two of them are herewith given with some of the accepted results, not because of any implied belief that a new thing is involved, but as an illustration of a manner of presentation which has been successful in the hands of average high-school pupils:

SIMPLE SOLUTION.

(a) Clean, dry and weigh the beaker. Add about five grams of pure sodium chloride, Na Cl, and weigh the beaker and contents. Calculate the weight of the sodium chloride.

(b) Completely dissolve the contents of the beaker in 100 c.c. of distilled water, transfer the solution to the flask and rinse the beaker twice into the flask, using about 25 c.c. of water each time. Fill the flask to the containing mark and note the volume of the solution. With the flask tightly stoppered with the thumb, stir the solution several times by inverting, and allow to stand for some minutes.

(c) Clean, dry and weigh an evaporating dish. By means of a burette, add to the dish 25 c.c. of the solution in the flask. Evaporate to dryness over a water bath. The dish and contents should be placed in the oven at 105 degrees C. for five minutes, then cooled and weighed. Weigh the dish and contents. Calculate the weight of the contents of the dish.

(d) Make the following observations:

1. Is the solid residue in the dish, salt.
2. What is the ratio in weight of the salt obtained in "c" to the total amount of salt (in "a") with which you started?
3. What is the ratio between the volume of the solution evaporated in "c" and the total contents of the flask in "b"?
4. Compare results in "2" and "3" and make a mathematical statement of the proportion, as

salt : salt :: volume : volume.

5. Predict the weight of salt to be obtained from a second 25 c.c. of the solution. Try it, and verify the results.
6. Is the sodium chloride uniformly distributed through the solution?
7. State some sources of error in your work.

Some results obtained (weights are in grams, and volumes in cubic centimeters):

Weight of salt...	2.61	3.66	5.00	5.00	4.35	6.29	4.99	2.09	4.21	12.32
Volume of flask..	250	250	200	250	250	200	200	250	250	200
Residue No. 1...	0.27	0.39	0.57	0.49	0.42	0.82	0.62	0.21	0.42	1.51
Residue No. 2...	0.29	0.37	0.58	0.48	0.42	0.81	0.61	0.20	0.42	1.45
Average ratio —	1:9.32	1:9.63	1:8.69	1:10.3	1:10 3	1:7.7	1:8.1	1:10.1	1:10	1:8.3
Correct ratio.....	1:10	1:10	1:8	1:10	1:10	1:8	1:8	1:10	1:10	1:8

The errors are easily accounted for, and by a comparison of results it is very readily possible for the most reluctant to arrive at the evident truth.

It is to be understood that only chemically pure substances are used, as the introduction of foreign matter largely diminishes the likelihood of success.

The experiment following presents an interesting fact, namely, that while the process is more involved, the quantities smaller, and the experiment as a whole of a higher grade than the preceding, yet the results are more satisfactory; indeed as good as could be asked under the conditions. While in practice the experiment with salt is given first, as simpler in the matter of manipulation, there are some difficulties to be encountered which materially aid in following experiments, and the usual effect is to make pupils more cautious in taking them up:

CHEMICAL SOLUTION.

(a) Clean, dry and weigh the dish. Add a strip of sheet silver weighing from 0.2 to 0.4 gram. Weigh accurately. Calculate weight of the silver.

(b) Place the dish and silver over a water bath, cover with diluted nitric acid, add two drops of concentrated nitric acid, cover the dish with a watch crystal; and after the silver dissolves remove the cover and evaporate to dryness. Wipe off the outside of the dish, heat to 105 degrees C. in the oven, cool and weigh. Calculate the weight of the crystals.

(c) Dissolve the crystals in about 15 c.c. of water, place over a water bath (individual), and when warm add an excess of sodium hydroxide, NaOH, a drop at a time. Stir the contents of the dish, taking care not to lose any of the dark brown precipitate, and as soon as the liquid settles clear, pour off the liquid, leaving the residue in the dish. Wash several times with water, decanting as before. The last washings should be neutral to litmus. Evaporate to dryness, heat in the oven at 105 degrees C. Cool and weigh. Calculate the weight of the brown residue in the dish.

(d) Place the dish and residue on a ring of the ring-stand and heat evenly with the blue Bunsen flame until the brown color of the residue is replaced by a white luster. Cool and weigh. Calculate the weight of the residue.

(e) Make the following observations:

1. Compare the weight of the residue in "d" with the weight of the silver used. Compare the products (?).

2. With a knife carefully scrape the silver from the dish and return to the instructor. To the remaining particles in the dish add a few drops of diluted nitric acid, warm and convey the solution to a test tube. Add 10 c.c. of water and two drops of diluted hydrochloric acid. Then add an excess of ammonium hydroxide (?).

3. Now take 5 c.c. of a solution of silver nitrate in a tube, add two drops of diluted hydrochloric acid, and then ammonium hydroxide in excess. Compare the results in "2" and "3." If "3" is a test for silver, what can you say about the nature of the final product in "d"?

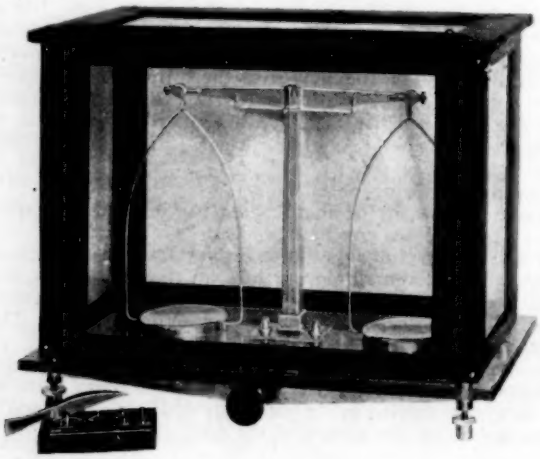
4. Are the changes in "b," "c" and "d" manifestly physical or chemical?
5. Has the treatment of the silver destroyed it?
6. Equations—These will be studied later. Put them down:
7. The underscored products in "b," "c" and "d" in "6" are respectively white, brown and white.

Some results obtained:

Wt. of silver	0.20	0.17	0.34	0.13	0.23	0.43	0.29	0.21	0.28	0.20	0.35	0.24	0.18
Wt. of crystals ..	0.33	0.25	0.54	0.22	0.36	0.67	0.49	0.33	0.43	0.32	0.57	0.39	0.29
Wt. of brown res. . .	0.21	0.18	0.38	0.15	0.26	0.46	0.29	0.23	0.30	0.22	0.40	0.26	0.21
Wt. of silver res. .	0.195	0.16	0.34	0.13	0.23	0.41	0.27	0.19	0.28	0.19	0.35	0.23	0.175
Error	0.005	0.01	0.00	0.00	0.00	0.02	0.02	0.02	0.00	0.01	0.00	0.01	0.005

In nearly every case the pupil readily observes that the loss may have occurred in the process of decanting, which loss with proper care might have been avoided and in every case the correct result was the work of the more thoughtful.

It is worth while to note that the weighings were made on balances sensitive enough to weigh to 0.01 g., estimating to 0.005 g. Very few took the trouble to estimate the latter, which, of course, could readily account for a portion of the error. These balances (we have ten of them), which were made to order, will appeal to teachers, and for their information the following illustration is given:

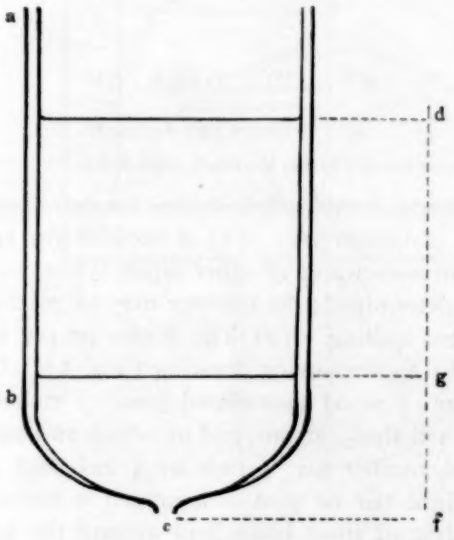


They are all glass and aluminum, costing less than $14 each, and after three years of use, standing in the main laboratory, are still in first-class condition. The only repairs so far needed were made this winter on the counterpoised doors of four of the balances, which had suffered unusual treatment at the hands of unskilled manipulators.

A DEMONSTRATION OF CAPILLARITY*

BY V. DVORAK.

The following demonstration is easily carried out and may be plainly seen even at quite a distance; it can also be nicely projected.



A glass tube *ab* (Fig. 1) 13 mm. in diameter is drawn down very abruptly so that its end *c* is as short and thin as possible; the diameter of the orifice is about 5 mm. If water is poured very

*Translated for "School Science" from Physikalische Zeitschrift, II, 223.

slowly into the tube, I found with my tube that the height of the water column was about 22 mm.; when more water was added a portion flowed out.

When alcohol is poured into the tube, the height *fg* of the liquid is considerably lower, though the specific gravity of alcohol is less than that of water. The column of liquid is supported by the surface film at *c*, and the surface tension of water is 7.5 mg. per mm., of alcohol only 2.5 (of ether 1.88).

Still more striking is the following experiment. The tube is filled as full as posssible with water. Then a few drops of ether are poured into a small beaker which is subsequently held up around the tube. The water begins to drop out at once but ceases to do so as soon as the beaker is removed. The vapor of the ether dissolves in the water at *c* and lessens its surface tension considerably.

AN "INDEXOMETER."

By J. Stewart Gibson.

Instructor in Physics, Wadleigh High School, N. Y. City.

The essentials of this simple device for determining the index of refraction of liquids are: (1) A tumbler (or any small cup) filled level-full with water or other liquid whose index of refraction is to be determined; the tumbler may be placed in a shallow dish to prevent spilling. (2) The device proper is figured one-half size in the accompanying drawing (Fig. 1). It consists of a horizontal bar of wood (paraffined pine) 5 inches long, 1 inch wide and $\frac{1}{2}$ inch thick, at one end of which and perpendicular to it is fastened another bar, $\frac{1}{2}$ inch by $\frac{1}{2}$ inch and 4 inches long. On this upright bar or post is arranged a movable sight-edge made of a strip of sheet brass bent around the post so that its edge projects backward (as figured) about $\frac{1}{2}$ inch perpendicular to the post and in the plane of its end face. The horizontal bar is notched on its under surface at the middle where a pin is driven through and cut off so that its point is just in line with the lower back edge of the bar. About an inch from the opposite end of the

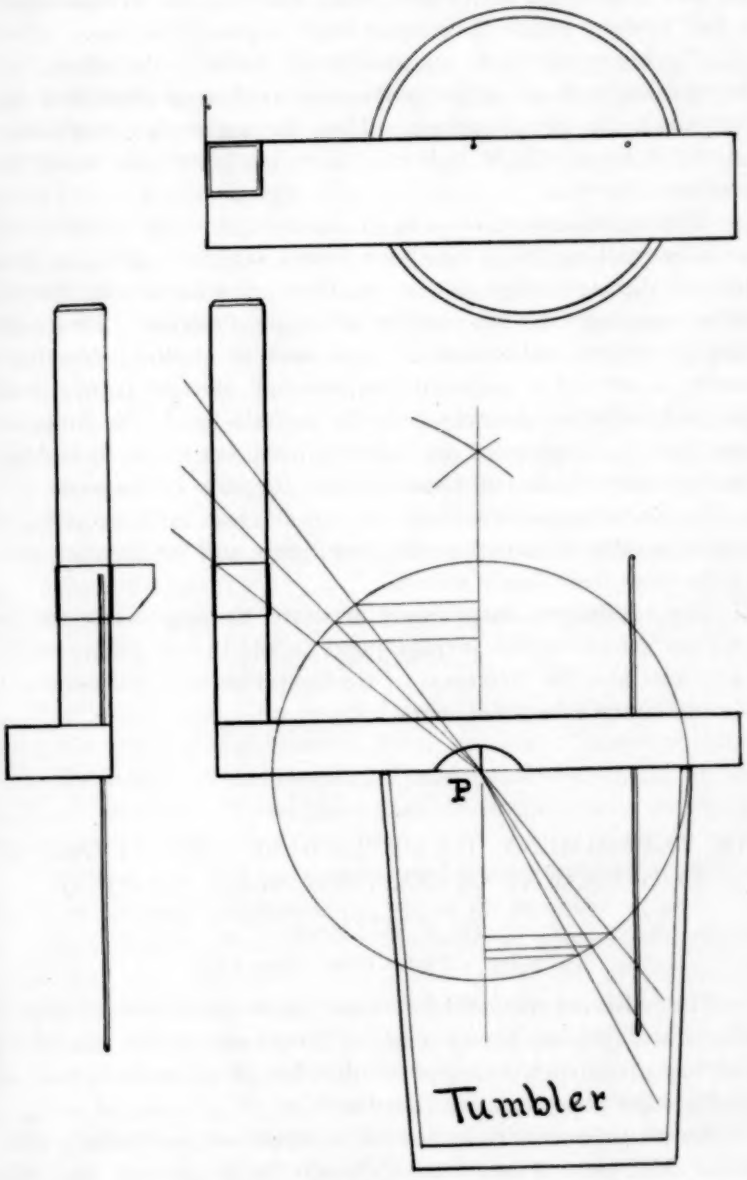


Fig. 1.

bar and close to the back edge a small hole is made through which a half knitting needle is thrust at right angles to the bar.

The bar is placed on the tumbler as shown in the figure, care being taken to have the pin-point come as close as possible to but not touch the liquid surface. Then the sight-edge is adjusted so that it appears to be in line with the pin-point and the needle-point in the water.

The measurement may be transferred directly to the note-book by marking off on two lines, drawn at right angles, the position of the sight-edge on one and that of the pin-point on the other, also marking the position of the needle-point. Then with any convenient radius and the pin-point as a center describe a circle; construct a perpendicular through the pin-point; draw the path of the incident ray from the needle-point to the pin-point, and that of the refracted ray from the pin-point to the sight-edge; finally construct, measure and compute the ratio of the sines.

By varying the length of the needle two or more pairs of angles may be measured in the same figure and the constant ratio of the sines thus clearly shown.

The results are surprisingly accurate, coming within one or two per cent with the average pupil; while the simplicity of the apparatus and the directness of the operation both recommend it for individual laboratory work.

AN EXPERIMENT TO DETERMINE THE APPARENT COEFFICIENT OF EXPANSION OF A LIQUID.

By F. A. Osborn.

Professor of Physics, Olivet College, Mich.

The following method of determining the coefficient of expansion of a liquid has been in use for three years in my laboratory and has given such excellent results that other teachers may be glad to have their attention called to it.

An air-thermometer bulb, with a rather large capillary stem, is the chief piece of apparatus. Weigh the empty bulb, and then fill it with boiled distilled water so that the water in the stem is

3 or 4 cms. from the bulb, when it is at the temperature of the room.

The bulb can be best filled by supporting it in a vertical position in a water bath with the open end of the stem connected to a small funnel by means of a rubber stopper. Pour the distilled water into the funnel and heat. Air will bubble out through the water; after a few minutes stop heating; the water will run into the bulb as the air contracts. Repeat these operations until the bulb is filled. Take the bulb out of bath and leave it to cool, removing the funnel when the bulb has reached the temperature of the room. The desired position of the water in the stem can be obtained by heating the bulb with the hand, thus causing some of the liquid in the stem to flow out.

The bulb, being filled to the desired point (which should be marked by a scratch on the stem), is now carefully weighed. The mass of the water in the bulb may be found from the two weighings. From a table get the density of water at the given temperature, and then compute the capacity of the bulb and stem up to the fixed point.

The capacity at 0°C. may be found by the equation:

$$v^{\circ}=v' \ (1-0.000026t).$$

The bulb is now to be emptied, dried, and the stem filled with pure mercury for a distance of 10 or 20 cms. Determine carefully the length of this mercury filament and the weight of the bulb and mercury. From these data obtain the area of the cross-section of the stem.

The work so far is preliminary, and is done by students in the fall term, as two exercises in the use of the balance.

The bulb is now to be filled with the liquid whose coefficient of expansion is to be found. Turpentine, sweet oil, glycerine are good liquids. When filled, immerse the bulb in finely crushed clean ice. When the liquid has reached the temperature of the ice, as shown by the liquid in the stem remaining stationary, mark position by sticking to the tube a piece of paper. Remove the bulb, place it in a beaker of cold water and raise the temperature about 20 degrees, if this temperature does not cause the liquid in the stem to overflow. Stir the water constantly and mark the

position of the liquid when it begins to fall after having reached its maximum point. Read the thermometer at this time. With a millimeter scale determine carefully the distance between the two marks.

From the data thus obtained, knowing the volume of the bulb and the cross section of the stem, the coefficient of apparent expansion may be computed. For if $v°$ be the volume of the liquid at 0°C., and v' its apparent volume at the temperature t, then a, the coefficient of apparent expansion, is given by the equation:

$$v' = v° (1 + a t),$$

or

$$a = \frac{v' - v°}{v° t}$$

DATA FROM A STUDENT'S NOTEBOOK.

Weight of bulb, full.....66.790 g.
Weight of bulb, empty.....30.960 g.
Weight of water.....35.830 g.
Weight of 1 c.c. of water at 12.2 degrees C..... 0.999 g.

Capacity of bulb and stem to fixed point (35.830 | 0.999)=35.865 c.c.
Capacity of bulb and stem at 0 degrees C., 35.865 (1—0.000026x12.2)= 35.844 c.c.

Length of mercury filament.....14.8 cms.
Weight of mercury and bulb.....35.576 g.
Weight of mercury..... 4.616 g.
Area of cross section of stem, 0.0229 sq. cm. Density of mercury, 13.599.

Elevation of surface of liquid in stem.	Temperature.	$v—v°$.	a.	Liquid.
11.30 cm.	15.0 degrees	0.2587	0.000481	Glycerine
12.30 cm.	16.4 degrees	0.2816	0.000479	Glycerine
10.40 cm.	13.8 degrees	0.2381	0.000481	Glycerine

A Dumas Tablet.—A bronze tablet in honor of J. B. A. Dumas has been placed in the house in Rue St. Dominique, Paris, where the brilliant chemist lived for many years.

Metrology.*

THE METRIC SYSTEM IN ENGLAND.*

Not long ago the eminent metrologist, Dr. F. C. Mendenhall, stated that the metric system had made more progress in five years in England than in thirty years in this country. Any one familiar with the literature of the subject will say this seems well within bounds. In fact, in our own country no single law has been enacted on the subject since 1866, whereas in England the last important act was in 1896.

Let us scan briefly the legislative history of this progress from the first important act of Parliament. The legal aspect of weights and measures and the controversy resulting would form an extremely fascinating volume of English history, and one having no small bearing on the revolutions in that country, starting from that Magna Charta, "the first legislative act in the English statutes at large" (Henry III., 1225), which had much to do with weights and measures. All such points must be left for future consideration, it being our present purpose to speak of that part of the subject which bears on the metric system only.

When in 1790 the constitutional assembly of France adopted Talleyrand's plan of decimalization, it was proposed that a joint commission from the Royal Society of England and the French Academy should work out the details of the plan. The failure of Parliament to reply to the request of the Royal Society and to accept has cost Great Britain more than a hundred years of metric misfortune and also placed her in the rear rank of nations as regards coinage. It was a gigantic mistake. It seems doubtful whether the coöperation of English scientists with the French would have materially changed the decimal division, though the nomenclature might possibly have been varied. Since that time Parliament has at various times appointed committees on weights and measures that continued to recommend the old systems, until 1862, at which time a select committee reported in favor of the

* Communications for the Department of Metrology should be sent to Rufus P. Williams, Cambridge, Mass.

metric system as best fulfilling the conditions of a simple and uniform system of weights and measures, but suggested that it be not made compulsory.

Following this recommendation, Parliament passed the act of 1864, legalizing the system, thus antedating by two years our own permissive law. The continued appointment of committees having the same object in view, shows as clearly as anything can that the systems in use at present are unsatisfactory, illustrating the thought that nothing is settled till it is settled right. In nearly every country this has been the history of metric legislation—first reaffirming the old, then patching it up, and finally abolishing it entirely and substituting a system in harmony with the arithmetic of civilization.

Four years later a bill for compulsory use in Great Britain barely escaped enactment, which again put back the reform. Tides fall as well as rise, and the act of 1864 was practically nullified in 1878 by a law which forbade the use of any weights or measures which were not Board of Trade standards. As this body knew not the meter and kilo, it became criminal for a citizen to employ them. It was no hardship, however, for permissive use among a people educated in an old system, no matter how crude, has never gained much more headway than permissive honesty among thieves. It was not until 1896 that this absurd law was repealed, and the legality of the metric system re-established. This is the last measure regarding popular usage which has passed, and like its predecessor contains no compulsion to either citizen or government.

What has been done outside of legislation? In 1890 there was formed the Decimal Association, with headquarters in London, "to promote the adoption of a decimal system of weights, measures and coinage in the United Kingdom." It was decided to try to decimalize weights and measures first and coinage afterward. Made up of a large number of educated, influential and business men, this organization is accomplishing much in molding public opinion, and enlightening the legislator and the tradesman. Its committees include members of the houses of Peers and Commons, of chambers of commerce, of school boards, of trades councils, as well as accountants, assayers, bankers, engineers,

electricians, manufacturers, merchants and foreign traders, scientists, shipowners, warehousemen, etc. Sir Samuel Montague, Bart., M. P., is president; J. Emerson Dowson, M. Inst., C. E., chairman of executive committee, and Edward Johnson, secretary. The names of members fill several pages. This live association, with its active secretary, is reaching out in every direction. It has influenced the educational department to require thorough teaching of the metric system in all the day schools, beginning, as is done on the continent, with the lowest grades. Such universal teaching in the schools is sure sooner or later to bring about metric reform. Compulsory education stimulates the production of textbooks, and as a result more works on the metric system were issued in 1900 than in any previous year. The association has arranged to give popular lectures on its favorite subject in the leading cities and towns, thus familiarizing the mechanic, the laborer and the banker with the new implements of culture. By a personal canvass, made largely by the secretary, 150 members of Parliament have pledged support to a metric law making the use of the system compulsory after two years, and twenty more members are known to favor it. Committees of Parliament have again and again urged the passage of a metric law. One of the latest ideas of the Decimal Association is an attempt to arrange a conference in Paris of official delegates from England, the United States and Russia for a concerted movement in those three countries. Business men are beginning to see that it is for their interest to hasten the reform movement. In Liverpool alone no less than ten of the largest commercial and manufacturing associations have come out ardent advocates of decimalization, nor is this exceptional, for in London and other large cities the same is true. Last June the Congress of Chambers of Commerce of the British Empire, held in London, passed resolutions strongly favoring the adoption and compulsory use of the international system. The great Salford Iron Works of Manchester issued instructions March 1, 1901, to draftsmen, manager and foremen, as follows:

> From this date in all plans for the works, or to be sent to customers, dimensions must be given in English measure and also in the equivalent metric measure. Measurements on new lithographed plans are to be similarly given in both measures. All plans to go out to countries in which the metric system is in general use must be dimensioned in metric measure only, etc.

As a sample of enlightened opinion combined with experience the following from the evidence of Sir Benjamin Baker, ex-president of the Institution of Civil Engineers, before the select committee of the House of Commons in 1895, is suggestive:

> I know hundreds of English engineers who have drifted necessarily into the metric system and the decimal system, and I have never heard one who would come back to the English weights and measures if they had the option.

With all the committees, chambers of commerce, manufacturing and mercantile associations, boards of trade and educational societies behind the movement, England seems much nearer to metric reform than is our own country. The members of these associations read from the reports of their consuls all over the world that Great Britain is at a serious disadvantage with her antiquated measurement units in regard to foreign commerce. At this time, when she is viewing with alarm the danger of losing to the United States the prestige of her manufacturing and exporting industries, by reason of vast concentration of wealth, and is feeling the necessity of laying hold of every favorable point of competition, it will be surprising if she does not within the next few years pass a compulsory metric law.

NOTES.

The American Metrological Society held its annual meeting April 19, 1901, in Washington, Dr. F. C. Mendenhall presiding. Prof. W. S. Stratton, the recently appointed director of the new Standardizing Bureau, gave an outline of its nature and functions, which will be described at length in a subsequent number of SCHOOL SCIENCE. He stated that the influence of the Bureau would be exerted in favor of the metric system. Dr. W. H. Seaman, of the Patent Office, urged that the next movement for the use of the metric system be upon the Post Office Department. Dr. Mendenhall stated that a letter weighing more than an ounce but less than 30 grams requires but one 2-cent stamp, he having made and sent such a test letter. Mr. A. L. Baldwin, of the United States Coast and Geodetic Survey, read a paper, the subject of which was not reported.

Various plans for promoting the adoption of the metric system were discussed. The sending to our new colonial possessions of school arithmetics containing our antiquated tables and problems of customary weights and measures, was deplored and a committee was appointed to

urge upon the departments the advisability of retaining the weights and measures already in use there—viz., the international system. Another committee was created having for its object the persuasion of the Post Office Department to adopt the metric system of weights.

An encouraging item was the statement that New England manufacturers are reported to have great interest in the system as necessary for the promotion of exports. A member who was present writes: "There were several events that seemed to show a stronger drift toward the metric system than I have ever seen before."—Prof. J. H. Gore, of Columbian University, is the Permanent Secretary.

Metric Reform in Denmark.—Mr. Jules Blom, formerly of the United States Consular service, writes from Copenhagen on Jan. 12, 1901, as follows: "In reply to your favor of Dec. 31 the chairman of the committee informs me that they are working hard on the introduction of the metric weight and measure system, but that he does not expect the law will be passed during the present session of the Danish legislative body. I shall watch the case and inform you as soon as there is an occasion."

Notes.

MISCELLANEOUS.

The Science Teacher's Vacation should be a season of growth, not of stagnation. While your work during the year has been hard and strength-sapping, it is not sheer idleness or absolute rest you need, but rather a change of occupation. Unless in poor health, it is not doing nothing that will prepare you best for the next year's work, but rather doing something that is a change from the old routine. If possible go away from home; get into new scenes and different surroundings for a time. Attend an educational meeting. The National Educational Association meets in Detroit, a very central and accessible location and convenient to the Pan-American Exposition at Buffalo. While the N. E. A. has not in the past been especially attractive to most teachers of science, there is a movement on foot to organize an auxiliary association for science teachers. Although this movement is still in the gristle, it has great expectations and asks the co-operation of all aggressive and progressive science teachers. Then there are the summer schools and the biological laboratories, as at Wood's Holl, Cold Spring Harbor, etc. You have been giving out all the year, why not take in a little during the

vacation? The change from teacher to learner is most refreshing. You can get more *real* rest by working in a summer school than you can by remaining dully at home. And the new things you will learn, the friendships you will make, the inspiration you will find, all will fit you for next year's work as nothing else can do. You will enter upon it with renewed vigor and confidence, you will find it more interesting and agreeable, your students will be benefited and your Board will be appreciative.

Free for the Asking.—A list of books in chemistry has been prepared by the New England Association of Chemistry Teachers. It contains about one-hundred annotated titles and was compiled by a committee of the association for the use of teachers and pupils in secondary schools. A copy of this list may be obtained without cost from the L. E. Knott Apparatus Co., Boston, Mass.—*The Ephemeris of Materia Medica, Pharmacy, etc.*, for January, 1901 (Vol. VI., No. 3), has just been issued by Dr. E. H. Squibb, Brooklyn, N. Y. Copies will be sent without charge to any interested applicant as long as the supply lasts. The information in this series of unique pamphlets is reliable, scientific and interesting. It is designed for those who are interested in the application of chemistry to medicine, especially to the newer remedies.—Baker & Co., Newark, N. J., have just issued for free distribution two placards, 16 to 30 cms., suitable for posting in the laboratory. One is a comparison of troy, avoirdupois and metric weights, and the other contains detailed directions for the care, use and cleaning of platinum ware.—The Eastern Association of Physics Teachers has issued an annotated list of books in physics adapted especially for teachers and pupils in secondary schools. A copy will be sent to any teacher on request by Mr. F. R. Hathaway, Secretary, Salem (Mass.) High School.

High School Scientific Club.—A small scientific society has been organized in the High School at Clinton, Iowa, and is proving a decided success. It is called the "Newtonian Club," in honor of Sir Isaac Newton, and its membership, consisting mostly of junior and senior students, is limited to twenty. Meetings are held in the high school building every Saturday evening, the program consisting of a leading paper by some one of the members, followed by discussion and voluntary reports on current scientific subjects. Some of the topics that have been dealt with so far are: "Unconscious Activities," "Is Mars Inhabited?" "Practical Uses of Compressed Air" and "Ants, Their Habits, Senses and Intelligence." Everything is quite informal, and some fascinating secret features contribute much to the interest. The society is planning some excursions to various points of interest in and about Clinton. It is the opinion of the writer that such societies should be established elsewhere in high schools, as they tend to promote interest and to bind student and teacher in one common cause.

The "Newtonian Club" is a subscriber to School Science.

Department of Physics and Chemistry. **LeROY D. WELD.**

ELECTRICITY.

The Number of Alternations of a current can be shown very nicely by the pitch of the note produced by an iron plate set in vibration by an electromagnet. An iron disk about 0.5 mm. thick and 20 cms. in diameter is fastened on a bed of felt in a wooden ring and clamped a few millimeters over an electromagnet. When a strong alternating current, as one from an electric light plant, is sent through the electromagnet, the disk starts to vibrate, and the pitch of the note produced is an indication of the frequency of the alternations. The note is surprisingly strong.

Zeitschr. f. phys. und chem. Unterricht, XIII. 313. **HANS LOHMANN.**

The Mapping of Electric Lines of Flow. A piece of filter paper is laid upon a glass plate and wet with a solution of zinc sulphate. Over it are sprinkled fine zinc filings. The terminals of a strong direct current (a house current of 110 volts) are pressed down upon the paper at some distance apart. When the circuit is closed the electrolytic precipitate from the filings soon brings out clearly the distribution of the lines of flow. Different combinations with respect to the number, position and form of the electrodes give rise to a great variety of figures. Beautiful figures are obtained when conducting substances, as metallic plates, are placed in the way of the current, or portions of the paper are cut away so as to interpose non-conducting places. Other electrolytes and metals may also be used, but zinc sulphate and zinc seem to give the best results.

Zeitschr. f. phys. und chem. Unterricht, XIII. 336. **A. ZINGER.**

Book Reviews.

Studies of Animal Life: A Series of Laboratory Exercises for the Use of High Schools. By HERBERT E. WALTER, WORRALLO WHITNEY and F. COLBY LUCAS, Instructors in Biology in the Chicago High Schools. 13x18 cms., vi. and 106 pages. D. C. Heath & Co., Boston. 1900. $0.50.

In the words of the authors: "The subject-matter of this book is animal life and not animal forms, the authors' point of view being to study living animals and to interpret their activities, so far as possible, instead of compiling a series of zoölogical obituaries."

It is refreshing not to be told again why it is better to go from the simple to the complex, etc., or that the study of animals may begin anywhere.

The microscope and the cell are the preliminary study. In a clever way the student is made to realize that the compound microscope gives an inverted image. Then Protozoa, Sponges, Coelenterata, Worms, Echinoderms Arthropoda Mollusca and Vertebrates are studied in the usual order given in such books.

Most of the studies consist of habitat (explained by instructor), hab-

its—observed usually in living animals in the laboratory—general external morphology as far as possible from live or fresh animals under observation, and internal anatomy in enough cases to give an idea of the location and appearance of the principal organs. Fortunately life activities form a large part of each study, as promised. The comparison that frequently follows —a type with its related form—is valuable, but it must be regretted that such comparisons are not used to convey the idea of relationships. We miss, likewise, all through, the doctrine of descent, and this omission is surely not due to the difficulty of the subject, for more difficult questions are asked and their answers expected.

The extent to which the question method is used is commendable. In too many books, mere directions lead the student to fitting his animal to the directions, and he loses, rather than gains, independence. But we believe it is a defect in the method when questions are asked that are beyond the pupil's ability to answer.

On the whole, the little book gives evidence of being based on experience, and readily commends itself to those intending to use a manual.

L. M.

Text-Book of Inorganic Chemistry. By Victor von Richter. Edited by Prof. H. Klinger. Authorized translation by Edgar T. Smith, Professor of Chemistry in the University of Pennsylvania (assisted by Walter T. Taggart). Fifth American from the tenth German edition. 14x21 cms., 430 pages. P. Blakiston's Son & Co., Philadelphia. 1900. $1.75.

The latest American edition of this standard text-book has substantially the same form and arrangement as its predecessors. It contains a large amount of authentic material in a limited space, and the typography allows the more essential parts to be readily selected from those of lesser importance. The main difference from preceding editions consists in the consideration given by the editor to the more recent well established discoveries and theories. The revision covers among other subjects the general properties and the measurement of gases, the recently discovered constituents of the atmosphere, the alloys, the electrolysis of salts and the theory of electrolytic dissociation in its different phases. The treatment of some of these topics is rather condensed, but it is sharp and to the point, differing markedly in this respect from the generous but often hazy consideration recorded in the larger books. In most cases the editor has retained the essential facts, leaving the reader to find for himself the illustrations and applications in the original articles, to which references are abundant. It is to be regretted, however, that the translator did not take the liberty—by all means warranted—to incorporate more references to English sources, especially since many important articles have been translated. The college teacher forgets that even though many teachers in secondary schools read German, they have no access to files of German periodicals. The same criticism may be made of the references to books. Scarcely an English book is mentioned, though the German titles are super-

abundant. This book is too difficult for pupils in secondary schools. It is, however, a good book for a school library. Teachers who have no recent book in inorganic chemistry will find this book a valuable adjunct to their library. Few adverse criticisms need be made. The illustrations are uniformly bad. The discovery of oxygen by Priestley is stated as 1771 instead of 1774. Willson, whose work on calcium carbide is well known, is spelled with one and with two l's. Metargon is recorded among the recently discovered gases in the atmosphere, but it is now known to be "non-existent." These and similar errors, however, do not detract from the general usefulness of the book.

LYMAN C. NEWELL.

Lessons in Botany. By GEORGE FRANCIS ATKINSON, Ph.B., Professor of Botany in Cornell University. 13x19 cm., xv. and 365 pages. Henry Holt & Co., New York. 1900. $1.12.

Professor Atkinson's book is divided into the usual parts under Physiology and Morphology and the now well recognized part under Ecology. There is one refreshing thing about the author's treatment of the subject of Physiology—he introduces with the experiments sufficient matter for reading and reference to keep up the interest while the student is necessarily waiting for the full results of the experiments, this matter being largely devoted to the structures and mechanisms by which the plants carry on their functions. Again, the author has broken over the common custom of confining physiological work to the phanerogams and has introduced a few cryptograms in their proper place for showing some of the simpler processes. It would have been better, so far as they are illustrative, to have introduced higher and higher forms as the higher and more complex functions were described. This would have given an equal balance to the lower and more developed forms, a balance rarely appreciated by the secondary school student.

Under Morphology are included two groups of facts. Perhaps rather with, than under, Morphology is brought out quite fully the significant life-history of representative forms. After the chapters dealing with these strictly, follow several chapters based on the characters of different plant families, bringing out in successive steps the gradual changes and developments, chiefly reproductive, of course, shown in a series from the simplest to the highest. This feature should give most excellent results in awakening the pupil's interest in the natural surroundings in which he is. And the author may be assured that this idea is not a prominent one in the long list of comparatively recent books on botanical study.

Under Ecology the author has taken up the more usual modern line of treatment, which needs no comment in this place.

It is a little unfortunate that the illustrations are to such an extent printed from rather dark plates. This makes too great a contrast between them and the text. The typography is excellent for the declared purpose of the book. The presswork is weak at the headings of chapters, where the upper margins are in many cases rubbed, otherwise very satisfactory.

E. L. M.

Books Received.

Experiments arranged for Students in General Chemistry. By Edgar F. Smith and Harry F. Keller. Fourth edition, enlarged, with 41 illustrations. P. Blakiston's Son & Co., Philadelphia, 1900. iii and 88 pages. 60 cents.

3500 Questions on Medical Subjects arranged for Self-Examination. Third edition, enlarged. P. Blakiston's Son & Co., Philadelphia, 1901. viii and 230 pages. 10 cents.

Wild Birds in City Parks. Being hints on identifying 100 birds, prepared primarily for the spring migration in Lincoln Park, Chicago. By Herbert Eugene Walter and Alice Hall Walter. Chicago, 1901.

Bulletin of the Geographic Society of Chicago, No. 2. The Plant Societies of Chicago and Vicinity. By Henry C. Cowles, Chicago. Published by the Geographic Society of Chicago, 1901.

Systematic Science Teaching. A Manual of Inductive Elementary Work for all Instructors. By Edward Gardnier Howe. D. Appleton & Co., 1900. xxix and 336 pages. $1.50.

Advanced Elementary Science, Being Part II of Systematic Science Teaching. A Manual of Inductive Elementary Work. By Edward Gardnier Howe. D. Appleton & Co., 1900. xiii and 373 pages. $1.50.

First Studies of Plant Life. By George Francis Atkinson. Ginn & Co., Boston, 1901. xii and 266 pages. 60 cents.

CLEARING HOUSE.

Teachers desiring to offer for exchange books, apparatus, etc., may insert a notice to that effect at the nominal rate of one cent per word, *in advance*.

Reports of Meetings.

NATURAL SCIENCE ASSOCIATION OF ONTARIO.

The association held its annual meeting in Toronto on April 9 and 10, in connection with the meeting of the Ontario Educational Association. At the first session an able address on "Nature Study for Observation and Information in Public Schools" was given by the President, W. S. Ellis, B.A., B.Sc., Kingston. After a very full discussion a committee was appointed to draft an outline of Nature Studies and to urge upon the Departments of Education and of Agriculture the necessity for making nature study occupy a more important place in the elementary schools.

Then followed the report of the committee appointed last year to draft a "Programme of Science Studies" for high schools. It was unanimously resolved to have the committee urge upon the Education Department the desirability of making radical changes in the present science programme, especially in the science required for junior students.

At the next session the association had the pleasure of hearing W. K. T. Smellie, B. A., principal of the high school, Deseronto, give a paper on "Charcoal Iron." Mr. Smellie pointed out the special field for charcoal

smelting in Ontario, where coal is difficult to secure. The Deseronto smelting works were described and used to illustrate the paper.

J. A. Fife, B. A., of Peterboro, gave an account of some original work done in connection with the Canadian woodpeckers, specimens of which he used for illustrating his field notes.

The secretary reported on "Recent Scientific Books." He called attention to the excellent little books for practical work in botany and zoölogy published by Messrs. Heath & Co. These were "Studies in Animal Life" and "Studies in Plant Life." Several volumes of Appleton's "Twentieth Century Series" were also exhibited and highly recommended to all teachers of science. Particular attention was called to "Plant Studies," by Dr. Coulter, and "Animal Life," by Drs. Jordan and Kellogg.

SCHOOL SCIENCE was brought to the attention of the members and sample copies were presented. The speaker showed the importance of having such a periodical to stimulate one's thought and keep one's teaching "up to date."

A joint meeting was held with the Physical Association, at which Dr. J. C. McLennan, of University College, gave a demonstration and a report upon "Some Recent Advances in Electrical Science," dealing in a scholarly way with leakages, etc.

In connection with the Educational Association the members had the pleasure, on Wednesday evening, of hearing Prof. J. W. Robertson, Dominion Dairy Commissioner, give an admirable address on "Manual Training." Professor Robertson, through the munificent gifts of Sir W. C. MacDonald, has been able to establish in every Province of the Dominion one or more schools to give an experimental proof that manual training should have a much larger place in all our work.

Reported by E. L. HILL.

INDIANA STATE SCIENCE TEACHERS' ASSOCIATION.

The sixth annual meeting of the association was held at the State Normal School, Terre Haute, on Friday and Saturday, April 26 and 27, 1901. The session of Friday morning was devoted to papers of a general character. The meeting opened with an address of welcome by President W. W. Parsons. Dr. D. W. Dennis, of Earlham College, followed with a very instructive paper on "The Culture Value of Science Study," in which he admirably showed that the modern presentation of science is calculated to furnish fully as high a grade of culture as that to be derived from the so-called humanities.

The acting president, G. W. Benton, of Shortridge High School, Indianapolis, followed with a brief address on "Professional Elasticity," in which he urged a broad culture, with unquestioned professionalism, but extensive contact with affairs out of the class-room and laboratory, and particularly business and travel experience. The session closed with the appointment of committees.

The afternoon session of Friday was opened by Dr. C. B. Davenport, of the University of Chicago, who gave "A Review of the Different Methods Employed in Teaching Biology." His paper dealt with the historic side of science teaching largely, showing the main reasons why in succession the text-book method, the lecture method, the class-laboratory method, the laboratory guide method, etc., had gradually passed away and why the study of nature, as proposed by Agassiz, but modified by the conditions of time and place, has become universally recognized by advance thinkers as the true way. He urged the teaching of truth as observed, not as the books describe it.

The discussion was opened by Prof. Donaldson Bodine, of Wabash College, and Prof. Mel. T. Cook, of De Pauw, who spoke in support of the general points of the paper.

The next paper was on the subject "Physics in High Schools and Grades," by President C. L. Mees, Rose Polytechnic Institute. The speaker took the ground that physics is the only science which has no place in the grades, it requiring too great maturity of mind for pupils at that age. He also expressed the conviction that much of the physics now taught in high schools was too technical, and beyond the ability of the mass of pupils. He thinks that to do very effective work in physics in the average school it will be necessary to materially simplify the course. Dr. Mees also said that not less than a year should be devoted to the subject, and more time could be used with profit if available, otherwise it should be omitted.

Dr. Mees' paper was discussed by Mr. Crowe, of Fort Wayne, and Mr. Bruce, of Princeton, who enlarged upon the necessity of simplifying the courses in high school physics and particularly the importance of the analysis of problems, as against the use of formulae.

Following the close of the afternoon session the members took a trolley ride over the new Terre Haute-Brazil electric line.

At 6 p. m. the members of the association banqueted at the Terre Haute house.

The evening session was devoted to an illustrated lecture on "Wireless Telegraphy," by Mr. W. J. Clark, of New York. The lecture was given in two parts; the first, illustrated by stereopticon, presented the historical phase of the subject, with a very clear presentation of the development of the induction coil and its applications. The second part was a practical demonstration of the work which can be done. The apparatus was well handled, and motors were run, lights turned on and off, messages sent, etc. The experiments worked to the entire satisfaction of the audience.

The closing session was held on Saturday morning. Dr. J. T. Scovell, of the Terre Haute High School, spoke informally on the subject of "Commercial Geography," sketching the history of transportation in this country particularly and calling attention to the present revival of

interest in ship canals and the prospects for future commercial progress as a result.

The first formal paper of the morning session was "The Study of Bacteria in High Schools," by Prof. A. J. Bigney, of Morris Hill. He favored the study of simple sanitary methods rather than the formal study of the science.

The paper was discussed by Prof. Rettger, Dr. Scovell, Prof. McBeth, Mr. Benton and others. Discussion favored the study of sanitary science from the non-technical side, but a feeling was expressed that it might profitably be placed in the lower grades, as a phase of nature study.

The last paper of the session was on "Nature Study in the Schools," presented by Mr. F. M. Mutchler, of Terre Haute. The paper was discussed by Prof. Caldwell, of the Eastern Illinois Normal School, Dr. Rettger, Dr. Scovell and others. Both paper and discussion advocated the teaching of simple truth to the exclusion of myth and fairy tale.

Officers were chosen for the coming year as follows:

President, J. T. Scovell, Terre Haute; vice president, J. H. Voris, Huntington; secretary, D. C. Weir, Indianapolis; treasurer, J. F. Thompson, Richmond; executive committee, M. E. Crowell, Franklin; L. E. Wheeler, Monticello; Leonard Young, Evansville; John Owen, Huntingsburg; Donaldson Bodine, Crawfordsville.

The papers and discussions will appear in the published proceedings to be issued some time during the summer, under the editorial direction of Prof. L. J. Rettger, State Normal School, Terre Haute, Ind.

Reported by G. W. BENTON.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

The eleventh regular meeting of the association was held Saturday, April 20, at the Institute of Technology, Boston, Mass. President Rufus P. Williams was in the chair and about twenty-five members were present. After the usual routine business the Committee on Reference Books reported verbally that their work had been completed and the list of books was ready for distribution.

In the course of the meeting a package of the list of books was received from the publishers, L. E. Knott Apparatus Company, for distribution among those present, and it was accompanied by a note stating that three copies were ready for mailing to each member.

It was voted to appoint a committee of three to consider the matter of chemistry as a college entrance subject and to report at the next meeting. Dr. Lyman C. Newell was appointed by the Association and Mr. Lyman G. Smith by the Executive Committee to serve with another on this committee (to be selected by the two members already appointed). Dr. James F. Norris, assistant professor of chemistry, Massachusetts Institute of Technology, was unanimously elected an honorary member

of the Association. There being no further business the members listened to an address by Dr. Norris on "The Relation of Tellurium to the Periodic Law." By way of introduction the speaker called attention to the fact that recent authorities do not give the periodic law the prominence it once held, especially Ostwald, who devotes only six pages to it in his last book (Grundlinen der Anorganische Chemic), and Prof. A. Michael, of Tuft's College, who ridiculed the law in a recent lecture before the Northwestern section of the American Chemical Society. Neither of these chemists, however, proposed a substitute, and until that is done Dr. Norris believed that the law should not be abandoned. He then pointed out the value of this law to teachers as (1) a clearing-house of many facts of inorganic chemistry which are otherwise disconnected, and (2) an incentive to research. The importance of the latter point was brought out by quotations from Mendeleeff's "Faraday" lecture, delivered in 1889, twenty years after the law was promulgated. In 1869 the atomic weights of about twenty elements, which did not fit the classification, were changed by Mendeleeff, and chemists immediately began to redetermine the atomic weights and properties of these exceptional elements, especially beryllium, uranium and antimony. A search for the predicted elements was instituted and all three were found—viz., gallium, germanium and scandium. But of the twenty exceptional elements only tellurium today seems doubtful, and the speaker frankly said that he was led to study this element because of its doubtful position in the periodic classification, though the immediate incentive to the work was the outcome of an effort to secure a method for determining tellurium similarly to the method for selenium (devised by Dr. Norris and his colleague, Dr. Henry Fay). The tellurium at first used was purchased in Germany and was expensive, in fact, as expensive as gold. The present source is the "mud" deposited in the tanks used in the electrolytic preparation of copper. A barrel of this mud was obtained through the courtesy of the refiners in Baltimore, and when worked over yields about fifty pounds of tellurium at a slight cost. Dr. Norris and his colleague have devised a simple method for obtaining pure tellurium from the basic nitrate. The speaker gave an account of the various atomic weight determinations, especially those of Brauner, who used the bromide method but obtained discordant results. Another method involving the determination of carbon was also found to be faulty because the carbon determination is not sufficiently accurate for atomic weight work. This method gave results between 125 and 126, while Brauner's hovered around 127.6, and the oldest method, that of Berzelius, gave 128. A method utilizing native Japanese tellurium agreed with Brauner's result and indicates that there is no other element in tellurium. Recent work on the isomorphism of the compounds of tellurium, selenium and the platinum metals shows that isomorphism cannot be used as a test unless the water of crystal-

lization is the same in the compounds. Hence the question as to the proper group to which tellurium belongs is still open. The work is now being conducted by Dr. Norris and Dr. Fay at the Massachusetts Institute of Technology along the lines suggested by the work of previous investigators—viz., (1) isomorphism, (2) compound nature, (3) improved method of atomic weight determination. The fact that pure tellurium is at the disposal of these investigators indicates so far (1) that tellurium is elementary, contrary to the prediction of Mendeleeff as to its compound nature, (2) that the isomorphism of its compounds gives so far insufficient evidence, though considerable work has been done on this point, (3) that the real source of difficulty is in the constant source of error in the previous atomic weight determinations, since the results of several methods of other investigators do not agree. The work on isomorphism is still in progress, and a new method for the atomic weight determination is soon to be tried—viz., reduction of tellurium oxide by hydrogen and weighing both water and tellurium. This method checks itself, since the sum of the weights of tellurium and oxygen must be 100 per cent. At the close of the meeting the members inspected the apparatus for preparing pure hydrogen and other devices used in this work. Specimens of tellurium compounds were also examined.

The second address was by Mr. Walter O. Adams, head chemist at the Boston works of Lever Brothers, on "The Manufacture of Soap and the Recovery of its By-Products." He said about one billion pounds of soap are made annually in the United States, and New England used about twelve pounds per capita. A brief statement of the chemistry of washing and of the physical and chemical properties of soap was followed by an elaborate description of the raw materials used in making soap. Four alkalis are used—viz., the carbonate and hydroxide of sodium and of potassium, and these are obtained mainly from the Solvay works. The fats used are mutton and beef tallow, grease, cocoanut oil, cotton-seed oil, olive oil (rarely), and rosin. The last named, while not a fat, saponifies and is used in making many kinds of soap; it is not an impurity or adulterant, but is a legitimate material and gives the soap valuable properties. Specimens of these raw materials were circulated and were fully described by the speaker. The different kinds of soaps were then described and exhibited, including the ordinary hard soap, floating soap (which is merely ordinary soap having air "turned in"), and transparent soap (which is simply the residue from a solution of soap in alcohol, glycerine or syrup)—"no especial pains," said the speaker, "being taken to remove the glycerine or sugar." These soaps—floating and transparent—are no purer than other kinds, but "they please the public." The speaker then explained and described the processes of soap-making, paying especial attention to the usual method of boiling and the extensive treatment necessary to prepare a good soap. Illus-

trations were shown of the "crutches," "frames," "slabber," and "cutter," which are used to prepare the soap for shipment and use after it is made. He then gave a brief description of toilet, milled, remelted and other special soaps, stating naively that many sweet-scented soaps are inferior to the common laundry variety. Samples of crude and refined glycerine—the main by-product—were shown and the process of recovery explained. The address was exceptionally instructive and was given with a charming informality which added to its interest.

A vote of thanks was given to the speakers, and after a further inspection of the numerous samples the meeting adjourned.

Reported by LYMAN C. NEWELL.

BIOLOGICAL CONFERENCE OF THE MICHIGAN SCHOOLMASTERS' CLUB.

The Biological Conference of the thirty-sixth meeting of the Michigan Schoolmasters' Club held its principal session Friday afternoon, March 29, at Ann Arbor, Mich. About two hundred were in attendance. After the meeting was called to order by the chairman, Dr. F. C. Newcombe, some announcements made and the minutes of the previous meeting read and approved, the programme was taken up.

Professor C. E. Barr of Albion College read a paper on "Nature Study in the Schools," of which the principal points are here given: The weakness of the "classical education" was shown by experimental proof. It fosters dependence, while science education fosters independence, hence strengthens and gives power. The object of nature study is not to introduce science into the grades but to imbue pupils with the scientific method; to preserve and improve the natural powers through personal observation and inference rather than permit them, as now, to atrophy through dependence on authority.

Professor W. J. Beal of the Michigan Agricultural College next read his paper on "How Shall a Young Person Study Botany?" He gave reminiscences of his student time under the elder Agassiz and Professor Asa Gray, bringing out the well-known method of Agassiz in contrast to that of Professor Gray, who kept up the student's interest by telling him much that he could not see. He referred to the newer way of teaching, as outlined in his pamphlet, "The New Botany." He advocated explaining much to students during the first half of their course, and after that making them work out things more independently. Books should not contain figures that can be copied. A list of good text books was referred to and Ganong's "Teaching Botanist" was especially recommended to teachers. Courses in special studies were suggested. The idea was conveyed that even quite young persons can make original observations.

This was followed by a paper on "Outline for a Year's Work in Botany," by Miss L. Lenore Conover, Detroit Central High School, in which she said: "The first half of a year's course in botany should include a

careful study of the structure and habits of the most familiar plants, the phanerogams. Then, when the unaided eye has been trained to see and the mind to correlate facts, the second half of the year may be profitably devoted to the natural history of plants, with the object of presenting the relations of plants to one another and to other things in nature. This should include frequent reviews of phanerogams, field work and a study of representative types of cryptograms in which the compound microscope is indispensable."

The next paper was on the related subject, "Suggestions for a Year's Work in Zoölogy," by Miss Elonia Andre of the Detroit Central High School. The principal points were: "A course in zoölogy for high-school pupils should be of educational value aside from zoölogical information, and should give the pupil as broad an idea as possible of animal life. The pupil must realize that the variety of form and habit in animals is but an expression of their adaptation to conditions of life, and that the whole animal kingdom is an evidence of the fitness of things in nature, and that the structure of an animal depends upon the manner in which its functions are performed. To get this conception of animal life the subject must be studied from three points of view: Ecology, Morphology, Physiology."

A short paper on "The Value of Supplementary Experiments," by Mr. L. Murbach, Detroit, Mich., centered around two points: When experiments are properly understood and carried out they are valuable means for discipline and for acquiring new facts. More than one experiment should be given to lead pupils up to a fact, principle or law; these were called supplementary experiments.

Next followed a paper on "Science in the High School," by Miss Dora R. Palmer of the Lapeer (Mich.) High School. Her principal statements were: The development of the habit of observing correctly lies at the foundation of all scientific study. Experimental work when properly done is of great value in science teaching. All feeling of haste should be suppressed. Scientific training is the one great object to be gained in the teaching of science. It is more important that the pupil acquire power in his observation and reasoning than that his mind be stored with isolated facts. Study is one great whole and all studies depend upon one another. If we would get good work in the sciences, the foundations must be well laid in mathematics, English and drawing."

After this Dr. S. J. Holmes of the University of Michigan read a paper on "Recent Work and Theories on Fertilization of Animals." He said in part: "The principal experimental work on fertilization in animals has been carried along on two lines—fertilization of enucleated fragments of eggs and artificial parthenogenesis. Boveri in 1889 fertilized enucleated fragments and these developed into plutei which possessed only the characteristics of the pluteus (larva) of the male parent. Recently Dr. Loeb has made the remarkable discovery that the unfertilized eggs of the sea-urchin when treated for a time with certain salt solutions and then put back into

sea water develop into normal plutei. Later Dr. Loeb found that a mere increase of osmotic pressure, whether by the action of chlorides or of organic compounds such as sugar and urea, is sufficient to stimulate the ovum to develop. It appears that there is a variety of stimuli besides that afforded by the spermatazoön which may start the process of development."

The programme closed with a lecture on "Recent Work and Theories on Fertilization of Higher Plants," by Dr. J. B. Pollock, University of Michigan, which was illustrated with lantern slides. Dr. Pollock gave a review of the most important recent discoveries in the fertilization of higher plants, including the motile antherozoids of gymnosperms, the antherozoids of the sunflower resembling those of ferns, the fusion of one of the sperm-nuclei with the fused endosperm nucleus in several of the monocotyledons.

Each paper was followed by discussion of its practical bearings.

A short conference of Physiology teachers, separately held, was addressed by Dr. V. C. Vaughan, Dean of the Medical Department of the University of Michigan. In part he said: "I believe that the curriculum of every high school should provide for a course in physiology or hygiene, or both. This course should in part at least consist of laboratory instruction. It should contain enough anatomical knowledge to enable the student to know the location and relative position of the various organs of the body. The anatomical part might be demonstrated on a manikin or by the dissection of one of the lower animals. The student should have some information concerning the nature of food and food principles and the economic value of foods.

"The laboratory course should provide for the study of some of the more interesting species of non-pathogenic bacteria, yeast, molds, etc. This part of the course might be arranged so as to awaken great interest in the average student, and I am sure that correct information along these lines is quite as likely to prove of value to him in future life as that obtained from any other source. In these days, when there are so many followers of psuedo science, I believe that the teacher of science in the secondary schools has a great chance to benefit his race by giving to the boys and girls in his classes the general fundamental facts concerning the physiological functions of the body and the causation of disease."

After discussion of the practicability of teaching high-school physiology by the laboratory method, expense and apparatus of such a course, Professor O. S. Mast of Hope College gave his experience in "Physiology Taught by the Laboratory Method." Some of the chief points were: "The value of the laboratory method of teaching any subject that can be taught by this method is no longer disputed. Laboratory periods shorter than one and one-half hours are not satisfactory. High schools having a half year's work in physiology, with three laboratory periods a week and two recitations, could complete the work in any ordinary text book for high

schools by the laboratory method. Any fairly well equipped physical, chemical or botanical laboratory will contain nearly everything needed; while the organs of animals and different kinds of foods and other things required for study can be gotten at any butcher's shop and grocer's store for almost nothing, so that the actual expenses of the course will be very little. Fifteen to twenty-five cents per pupil would cover all expenses occurring from year to year. There is no longer any valid reason why there should not be a laboratory course in high-school physiology."

Reported by L. MURBACH.

PHYSICS CONFERENCE OF THE MICHIGAN SCHOOLMASTERS' CLUB.

The annual physics conference in convention with the Michigan Schoolmasters' Club was held at Ann Arbor on March 29 and 30, 1901. Its work consisted almost wholly of the exhibition of pieces of apparatus, their description and how used. The program was as follows: "The Inclined Plane," by Mr. De Forest Ross, Ypsilanti; "Modification of Whiting's Method of Determining the Acceleration Due to Gravity," by Mr. J. F. Selleck, Durand; "Coefficient of Expansion of a Gas at Constant Volume," by Prof. F. A. Osborn, Olivet; "Coefficient of Linear Expansion," by Mr. C. S. Cooke, Detroit; "Dynamical Measurement of Force," by Mr. N. H. Williams, Indianapoiis; "Foucault's Pendulum Experiment," by Mr. G. J. Burgess, Ann Arbor; "Reflection from Plane Surfaces," by Prof. E. A. Strong, Ypsilanti; "The Sonometer and Its Use," by Mr. C. F. Adams, Detroit; "A Simple Optical Bench," by Mr. F. R. Gaston, Ypsilanti; "Physical Laboratory Plans," by Messrs. Parrott, Ross, Adams, Cooke and Hawkes; "An Electrical Lantern for Laboratory Use in Optics," by Mr. H. N. Chute, Ann Arbor; "Rating a Tuning Fork," by Mr. F. L. Cooper, Manistee; "Downward Pressure in Liquids," by Mr. H. D. Minehin, Detroit; "Experimental Proof of Ohm's Law," by Mr. C. F. Adams, Detroit; "The Measurement of Candle Power," by Prof. F. A. Osborn, Olivet; "Measuring Focal Lengths," by Mr. A. O. Wilkinson, Detroit; "Modification of Kundt's Experiment," by Mr. E. H. Harriman, Ann Arbor; "Focal Length of Concave Mirror," by Mr. C. F. Adams, Detroit.

Great interest was taken in the work of the conference, as was shown by the large attendance and unabated attention throughout the long and varied program. It is expected that of the papers presented some will find a place in subsequent numbers of SCHOOL SCIENCE. At the business meeting H. N. Chute, of Ann Arbor, and C. S. Cooke, of Detroit, were re-elected chairman and secretary, respectively. A committee was appointed to confer with a similar committee appointed by the Michigan Academy of Science to take into consideration the question of making the Physics Conference of the Schoolmasters' Club the Physics Section of the Academy of Science. A committee was also appointed to devise ways and means of securing a prompt and satisfactory publication of the proceedings of the conference.

Reported by H. N. CHUTE.

NEW YORK PHYSICS CLUB.

The eleventh regular meeting of the club was held at the Erasmus Hall High School in Brooklyn on Saturday, February 16, 1901. After the routine business the election of officers resulted in the choice of the following for the ensuing year: President, J. S. Gibson, Wadleigh High School; vice president, J. M. Jameson, Pratt Institute; secretary, H. J. Weed, Manual Training High School, Brooklyn; treasurer, F. B. Spaulding, Boys' High School, Brooklyn. A report of the committee on apparatus was presented by J. M. Jameson. The following papers were read: "The Lecture Method as Applied in the Teaching of Physics," by Walter Barnwell, Columbia Institute; "Physics a Culture Study," by H. C. Cheston, DeWitt Clinton High School. After a generous lunch provided by the teachers of the school two instructive papers were presented by E. R. Von Nardroff. The first one was on "The Acoustical Analogue of Fizeau's Experiment on the Velocity of Light." A large reflector, two feet in diameter and ten-ft. radius, was used. A small whistle attached to a gas cylinder was the source of the sound, while a sensitive flame was used as an indicator of the recurring eclipses. The second demonstration was on "Diffraction Gratings for Sound." The grating consisted of a series of wooden slats, and the resulting phenomenon was analogous to that produced by diffraction gratings on light.

The twelfth regular meeting of the club met at the Peter Cooper High School on Saturday, March 23, 1901. After the routine business an elaborate and instructive report on "Current Events" was presented by M. D. Sohon. Among the laboratory devices presented were (1) "A Diffraction Grating of Simple Design," shown by E. R. Von Nardroff. This consisted of two short rods fastened together parallel about two inches apart and then wound around with fine wire. The wire was then soldered to the rods and one-half of it cut away so as to leave a number of the wires tightly stretched and close together; (2) "An 'Indexometer' by J. S. Gibson. This is given in full in another part of the magazine; (3) "A Calorimeter Jacket" by C. W. Harrington. This was made of felt commonly used to wrap around steam pipes; (4) "Illustrations of Capillarity by means of the Lantern" by W. F. Knox, Dr. Sachs' Collegiate Institute. A discussion followed upon the "Educational Value of an Experiment"; (1) "The weight of a Unit Mass of a Substance," by C. L. Harrington, A. L. Arey, and P. R. Dean; (2) "Latent Heat of Melting," by T. H. Currie, L. V. Case and M. D. Sohon. After a lunch tendered to the club by the teachers of the building the meeting adjourned.

Reported by R. H. CORNISH.

Correspondence.

QUESTIONS FOR DISCUSSION.

Teachers are invited to send in questions for discussion, as well as answers to the questions of others. Those of sufficient merit and interest will be published.

21. In a half-year course in botany, how much time should be devoted to the cryptograms, if one is provided with the necessary apparatus, and how much to a special study of the angiosperms?

22. To what extent should a pupil doing laboratory work be thrown upon his own resources in the overcoming of any difficulties of manipulation that may arise?

23. Why is it that students of the physical sciences do not usually know how to do the simplest algebraic work, even though they have had courses in algebra and geometry?

24. How can the poor mathematical work done by students of the physical sciences be improved?

25. What is a rigid and clear definition of the terms "lecture," "recitation" and "quiz," as used in high-school work in science?

26. What is the best material for a chemical table top—wood, glass, tile, soapstone or what?

27. What is the best material for a chemical table sink—lead (autogenously soldered), enameled iron, soapstone or what?

28. Does the presence of iron, as gas pipes, bolts, etc., in a physical table top interfere with the success of the experiments in electricity and magnetism given in the usual course in elementary physics?

29. Which are better—fume chambers on chemical tables where the student works, or at the side of the room?

30. The study of lower forms of plants in the laboratory suggests the need of a window case for the culture of mosses and ferns. The writer desires information from any one who has had experience in the use or construction of such a case, where mosses and ferns may be cultivated from the spores to the spore-bearing plants.

Detroit Central High School. **L. LENORE CONOVER.**

DISCUSSION OF QUESTIONS

13. *Should a teacher in a secondary school teach his own research work during a year's course in any science, to the detriment of the student's best broad knowledge of the subject?*

"To the detriment of the student's best broad knowledge of the subject," most assuredly not! But if the student is blessed with a teacher capable of doing research work and *actually doing it*, his enthusiasm and interest may be greatly increased by letting him get a hint of the methods, a peep at the apparatus in use. Too often a student believes that the writer of his text-book discovered or "made up" all that is in

it. The names tacked on to laws which he tries to commit to memory mean nothing to him. He has but a dim idea that science is being made more rapidly now than ever before. But if he is aware that his teacher is engaged in trying to wrest something out of the great Unknown, that there is an infinite amount of science yet to be made, his work becomes alive with interest. And if he can be led to believe that he, too, can after sufficient preparation attack the unsolved problems of science the quantity and quality of his work will be voluntarily doubled.

L. E. C.

15. *To what extent should teachers of one science be acquainted with the other sciences?*

Specialization is at once a bane and a blessing. Constant attention to one little field narrows one's views and throws this field all out of perspective. The teacher of a single branch of science often warps the minds of his students through his unwarranted magnification of his own specialty. On the other hand, however, it is only by unceasing study and observation of a single small part of nature that science advances. Nature as a whole is too vast for the comprehension of even a twentieth-century Humboldt, and man with wise ignorance is multiplying the number of what he in his impotence calls branches of science. A true teacher of science cannot but be attracted more by one of these branches than by the others, and he may count himself as very favored if he can give his time and attention to that one branch. He should not, however, as a true teacher, neglect to cultivate enough of an acquaintanceship with the other branches to recognize that while his own specialty is personally most interesting these other branches are fully as important. He should not elevate himself into a tower of specialism and look contemptuously down upon those who may choose to be interested in other phases of nature. He should particularly endeavor to impress upon his pupils the all-sidedness of things, and to widen their horizon. He should try to show how his own specialty is intertwined and interlaced with others, to point out that its boundaries merge imperceptibly into those of others.

17. *Are high-school pupils capable of taking lecture notes in science instruction understandingly and with profit?*

The main object of taking notes of a lecture is to get into a permanent form for future reference and study that which has been taken in by the ear. The shorthand reporter can reproduce the words of a lecturer, barring, perhaps, a few technical ones, without having any understanding of the subject before or after the lecture, and the only "profit" he may get out of it will be mostly of a pecuniary nature. Our students are not, however, masters of shorthand; very few of them, indeed, are masters of longhand, as regards legibility, punctuation and spelling. It is simply impossible for the average student to give in his notes anything like a

faithful transcript of what he has heard from the lecturer. Should, then, all note-taking of lectures be done away with? By no means!

The "lecture" in high-school work in science should deal with matters explanatory of or supplementary to the knowledge gained by student from the text-book or laboratory. It should be enunciated slowly and distinctly and the main points brought out very clearly. The student should not be allowed to attempt to note down everything that is said, but attention should be called to the matters to be noted and time should be given to note them down. This must not be a mere dictation exercise, but the student should write out in his own language, crude as it may be at times, the points which have been emphasized. Time need not be lost in thus giving the pupil a chance to use his pencil, for the lecturer may pause a minute or so to arrange apparatus for a demonstration or to put something on the blackboard. The ability to note down the argument of a lecture comes with practice, and plenty of practice is needed before the student becomes even moderately proficient. In these days when almost everything gets into print, whether it be worth it or not, the ability to take clear and accurate notes of spoken words may be regarded by some as of doubtful value. But values are relative. While the information in high-school work may be obtained from sources other than the teacher's lectures, yet proficiency in note-taking often stands one in good stead long after the student days are gone. The training of the powers of attention and concentration is also not inconsiderable in work of this kind. Note-taking has even more cultural than informational value.

It is an excellent plan to have the students prepare for a quiz on their notes after their memory of the lecture has somewhat faded. The student will then learn wherein he failed in his note-taking and where improvements can be made, and will be better prepared for the taking of notes in subsequent lectures.

L. E. C.

16. *How and to what extent should the history of a science be taught in an elementary course?*

One of the most difficult things in mental effort is to keep the attention fixed for some time on one point, especially if that point be hard to understand. And yet the more intense the attention the sooner the difficulties disappear. Attention is impossible without interest, and especially is this true in the teaching of certain parts of science. The successful teacher is the one who can get the "willing mind" from his students, and he can get this only in proportion to the interest and enthusiasm he can arouse. Experiments and demonstrations of themselves seldom fail to arouse and hold the attention, but science teaching cannot by any means consist of experimental work alone. How can we secure from our students this "willing mind?"

My experience has been that the introduction of historical matter

into lectures and recitations is productive of much interest. In assigning a lesson from a text-book I find that a brief anecdote or biographical note pertaining to the subject invariably whets the pupil's appetite and makes the preparation of the lesson less irksome. The subject takes on a humanistic aspect, and loses in a measure its "text-book aridity"; it becomes alive and fraught with human interest. Historical references in a recitation enliven even the dullest part of a subject.

The great difficulty in the way of a general use of the "historical method" is the lack of sources. There are only a few books on the history of science, and these are too high-priced for the students themselves to purchase. A desideratum would be the publication of a series of reprints of science classics at such low prices that pupils could provide themselves with them without much outlay. Until this lack of sources is supplied, about the only means of introducing the "historical method" into teaching is by lectures and occasional references to what historical matter may be at hand. The teacher should know the history of his science and should continually draw upon that knowledge in the class room. Apt historical references cannot be too numerous. The student learns from them not alone science, but history as well—and this history is the most important kind of history, a knowledge of which he will hardly get elsewhere.

C. E. L.

In the teaching of science the historical part should not by any means be neglected. It seems to me that our text-books do not lay enough stress upon the way in which discoveries have been made, upon the successive efforts that have been put forth to arrive at the truth, to clearly prove the laws of nature and point out their applications. A historical sketch has the advantage of making us understand how a discovery is made, what errors are to be avoided and what is the true method. The history of science is not alone written in honor of those who have contributed to its advancement; it is full of suggestion and inspiration for present generations, inasmuch as it marks the path thus far taken and points out the one we are to follow.

ALFRED MAURY.

We take this occasion of entering a protest against the ordinary text-book method of giving instruction in science. It would seem, from the reading of some books, that science had issued, all armed, from the brain of humanity. All that slow, patient work to which each generation contributed its efforts is lost sight of in a dogmatic exposition, which seems to be a revelation, to be hardly human and not to be subject to discussion. Science is thus separated from its natural tendency, which is the continual and intelligent discussion of all its parts.

M. DEHERAIN.